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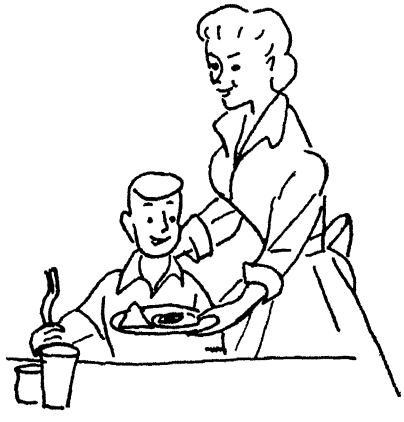

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NUTRITION OF A GROUP OF SCHOOL CHILDREN IN OHIO WITH IMPROVED DIETS

MARY BROWN PATTON, DOROTHY TYRRELL, ALICE F. CARVER, FERN E. HUNT and MARGARET THORNBURY

FOREWORD

The value of a study such as the one reported in this bulletin is two-fold. The quantitative information on the nutrition of school children for a continuous period of several years is in itself a contribution. In addition it points to the fact that if nutrition education programs are to be effective they must be based upon need, planned to keep up interest and have the support and cooperation of many people. Parents are not the least of these in importance for they as well as children must assume the responsibility of learning about and accepting dietary practices that will provide optimum health for the family.

INTRODUCTION

A survey of 9-, 10- and 11-year-old children in Iowa, Kansas and Ohio (1) during 1948-51 revealed that younger children ate better than older ones and boys ate better than girls. In general, the diets of the children for whom records were kept were classed as fair to good with only one child in 6 in Ohio having an excellent diet according to standards commonly used by nutritionists. The nutrients most frequently lower in amounts than recommended were calcium, ascorbic acid and vitamin A value.

In light of these results, a longitudinal study was planned to provide information on the general health and growth of a group of Ohio school children on an improved diet. Simultaneously observations were made on the factors influencing food acceptance and food habits of school children.

The general plan and methods used in the longitudinal study were similar to those followed in the mass survey mentioned above. Repeated observations were made on one group of children over a period of 3 years. Findings are reported in this paper in 4 parts, as follows: (a)

This study was supported in part by regional research funds from the North Central Region Cooperative Project NC-5, Nutritional Status and Dietary Needs of Population Groups, and in part by a grant from the Institute of Nutrition and Food Technology, The Ohio State University.

dietary findings, (b) blood findings, (c) physical measurements and (d) dental and physical inspections.

An elementary school with grades 1 through 8 was selected for this study because of its accessibility from the workers' headquarters, excellent cooperation of school personnel in previous contacts, a current school lunch program and a student body of suitable size and make-up. Approximately half of the children were from farm families and the other half, from families of full or part-time industrial workers.

Some children moved away from the community during the course of the study and others moved in after observations were underway. A total of 122 children were included in records during the 3 years but only 70 (37 girls and 33 boys), ranging in age from 8 to 12 years at the beginning of the study, continued throughout. Data for only those who continued over the full 3 years are included in this report. Distribution of the 70 children by sex and age is shown in table 1.

TABLE 1.—Distribution of children by age and sex at the beginning of the study

Age	Boys	Girls
8	5	6
9	14	12
10	6	16
11	5	3
12	3	0
Total	33	37

Age of a child was determined from the point midway between birthdays; for example, a child was considered to be 9 years of age from the time he was 8.5 years until he reached 9.5 years. The children were divided into groups according to age at the beginning of the study, and these groupings are used throughout this report.

Twelve of the 70 children did not participate in the school lunch program. They served as a self-selected control group for certain phases of the study.

The 3 years during which most of the information on the children was collected extended from September, 1953, to June, 1956. This interval was divided into 3 periods which are referred to in this report as periods A, B and B'. The first year of the study (period A) served as a time of observation previous to supplementation, and in the second and third periods (B and B') the supplementation program was carried

out. No data were collected during the summer months when school was not in session. Physical measurements were continued through the school year 1956-57 (period C), the year following the conclusion of the supplementation program.

A practicing physician from a neighboring community inspected the children for clinical signs of malnutrition in the fall and spring of each of the 3 years of the longitudinal study. At the same time dental inspections of permanent teeth were made by a dentist from the community. Reports of the findings for each child at each dental inspection were mailed to his or her home.

PART I. DIETARY FINDINGS

PROCEDURE

Dietary Records. With supervision and/or aid from a parent or teacher, the children kept records of all food eaten and any vitamin or mineral supplements taken on 3 consecutive days (Tuesday, Wednesday, Thursday) in one week during each of the months of September, December, March and May for the duration of the study.

Nutritive values of these recorded diets were calculated from values in USDA Handbook 8 (2) or **Food Values of Portions Commonly Used** (3). During the first year of the study, in carrying out a plan of noninterference in procedures in the school lunch program, workers estimated sizes of servings. Standard-size serving utensils were furnished after the first year, providing a means for a better approximation of amounts of foods served in the school lunch during the periods of supplementation.

The amounts of calories and 8 nutrients in each child's daily diet were calculated and averages were made for the 3-day periods. In addition, averages for each period (A, B and B') were made for individual children and for groups. These averages are used as the basis of discussion in this paper.

Means for calories and 8 nutrients in the children's diets were compared with the Recommended Allowances of the National Research Council (1953). Interpolations were made where necessary, and as children moved from one age group into another within a period during the 3 years, this was taken into account.

Classification of Diets. The children's diets were classified into 3 groups as follows: (a) those in which the average daily intakes of all nutrients were 100 percent or more of the recommended allowances; (b) those with some nutrients less than 100 percent but none less than

67 percent of the allowances; and (c) those with at least one nutrient less than 67 percent of the allowances. The first classification is referred to in this report as group I; the second, as group II; and the third, as group III.

SUPPLEMENTATION

As noted earlier, the first year of the study, period A, served as an observation period in which there was no interference with the routine of the school lunch program. During the second and third years, periods B and B', on the basis of information obtained in period A, the children's diets were supplemented with foods rich in vitamins C and A and in calcium. Additional protein-rich foods were provided also to help defray the expense of keeping protein at the level required by the National School Lunch Act.

Mid-morning Supplementation

All children in the study were given reconstituted frozen orange juice daily at mid-morning during periods B and B'. At the same time a supplement providing vitamins A and D (Oleum Percomorphum[1]) was offered daily at school during the winter months.

Ascorbic Acid. A serving of orange juice to provide 50 mg ascorbic acid was planned to supplement that which the children obtained from vegetables and fruits served as a part of the school lunch. The calculated ascorbic acid value of this supplement was slightly lower than this during the first year of supplementation but was increased the second year.

Vitamins A and D. Supplementation with vitamins A and D was planned with a medical doctor. Upon his advice 2 drops of the vitamin concentrate, Oleum Percomorphum, contributing 2500 I. U. of vitamin A and 360 I.U. of vitamin D, were given to the children on a small cube of bread.

Written permission was required from parents in order for the children to receive this supplement at school. The parents were asked also for the name and amount of vitamin or mineral supplements given at home, if any. A few parents did not give permission although their children's diets were low in these nutrients and no supplement was given at home.

School Lunch

In the second year of the study, period B, research workers in cooperation with the school lunchroom personnel made several changes in the

[1]Supplied through the courtesy of Mead Johnson and Company, Evansville, Indiana.

lunch in an effort to provide optimum nutritional value without extra cost to the school. For example, 3 times a week sufficient protein-rich foods were supplied free of charge to provide each participant a 2-ounce serving as specified for type A lunches under the National School Lunch Program.

About 3 times a week fruits and vegetables were provided without cost to the school as a part of an education program with a two-fold goal—to widen the children's acquaintance with a variety of vegetables and to add sources of vitamins A and C to their diets. This has been reported (4, 5, 6).

Milk solids equivalent to a half cup skim milk per serving were added 3 times a week to main dish type foods and to desserts to increase both the calcium and the protein levels of the diets. With these supplements, caloric values of the diets were automatically increased also.

Special School Milk Program

In August of 1954 Congress approved funds to be used to establish the Special School Milk Program (7) making fluid milk available to school children at low cost. In period B' the children could avail themselves of this additional milk at noon, during mid-morning or mid-afternoon or at all 3 times through this plan whether they took part in the school lunch program or not.

RESULTS AND DISCUSSION

PRELIMINARY PROGRAM (Period A)

Ten percent of the children's diets in period A were classified in group I (all nutrients 100 percent or more of recommended allowances); 60 percent in group II (some nutrients between 67 and 99 percent of recommended allowances); and 30 percent in group III (some nutrients less than 67 percent of recommended allowances). In general, those diets in group II failed to meet recommended allowances for more than one nutrient whereas the majority of diets in group III were below 67 percent for one nutrient and at the 67-99 percent level for most of the others. Diets were placed in group III because of low calcium values more often than for any other nutrient.

Among children in this study, as in the preceding survey of 9-, 10- and 11-year-olds from Iowa, Kansas and Ohio (1), individual intakes were somewhat low in ascorbic acid and vitamin A as well as calcium more often than in other nutrients.

Sex. The percentages of the boys' and girls' diets in groups I, II and III were similar but slight differences in level by sex occurred for specific nutrients (fig. 1).

Clayton and Ullman (8), in the analysis of diet records of a group of junior high school children in Maine, found that the students' diets were most often deficient in milk products and the fruit and vegetables having high vitamin A and/or C content. The boys' diets were lower than the girls' in amounts of foods high in vitamin A. Those of the girls were lower in milk and milk products. Similar tendencies for sex differ-

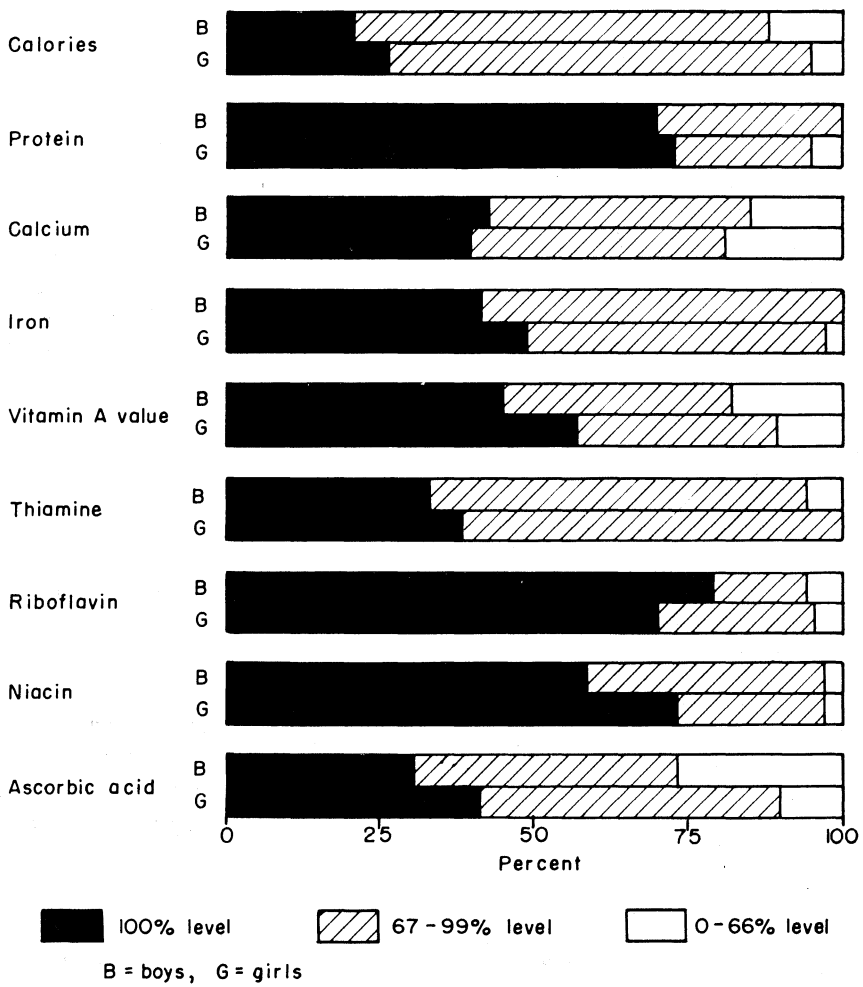

Fig. 1.—Percentages of boys and girls meeting 3 levels of recommended allowances (NRC) for calories and 8 nutrients in period A.

ences among these Ohio children were found in period A. More boys than girls met their recommended allowances for calcium and riboflavin in period A which probably indicates a greater milk consumption by boys. Girls' diets contained more vitamin A than the boys' which may be related to amounts of green and yellow vegetables eaten (fig. 1).

Age. In general, the younger children had diets more nearly meeting their recommended allowances for calories and 8 nutrients than did older children, as shown in the following distribution by age and nutrient level:

Age	No. cases	Nutrient Level		
		Group I	Group II	Group III
8	11	36	55	9
9	26	8	65	27
10	22	5	67	29
11	8		33	67
12	3*		67	33

*Boys only.

Similarly, Marlatt et al. (9), in a pilot study among selected groups of children in Iowa, Kansas and Ohio, found that the 6- to 8-year-old children met or approximated the recommended allowances for all nutrients. For children 12 and over the average values fell short for many nutrients.

Since all of the children did not participate in the school lunch provided under the National School Lunch Program, diet rankings for period A grouped according to participation in this program were compared (fig. 2). The difference in size of the 2 groups should be noted. Similar proportions of children in both groups met 100 percent of their recommended allowances, but proportions meeting 67-99 percent and below 67 percent for some nutrients were markedly different for the 2 groups of children.

SUPPLEMENTATION PROGRAM (Periods B and B')

The supplementation program carried out in periods B and B' is discussed under the following subheadings: (a) mid-morning supplementation, (b) National School Lunch Program and (c) the Special School Milk Program.

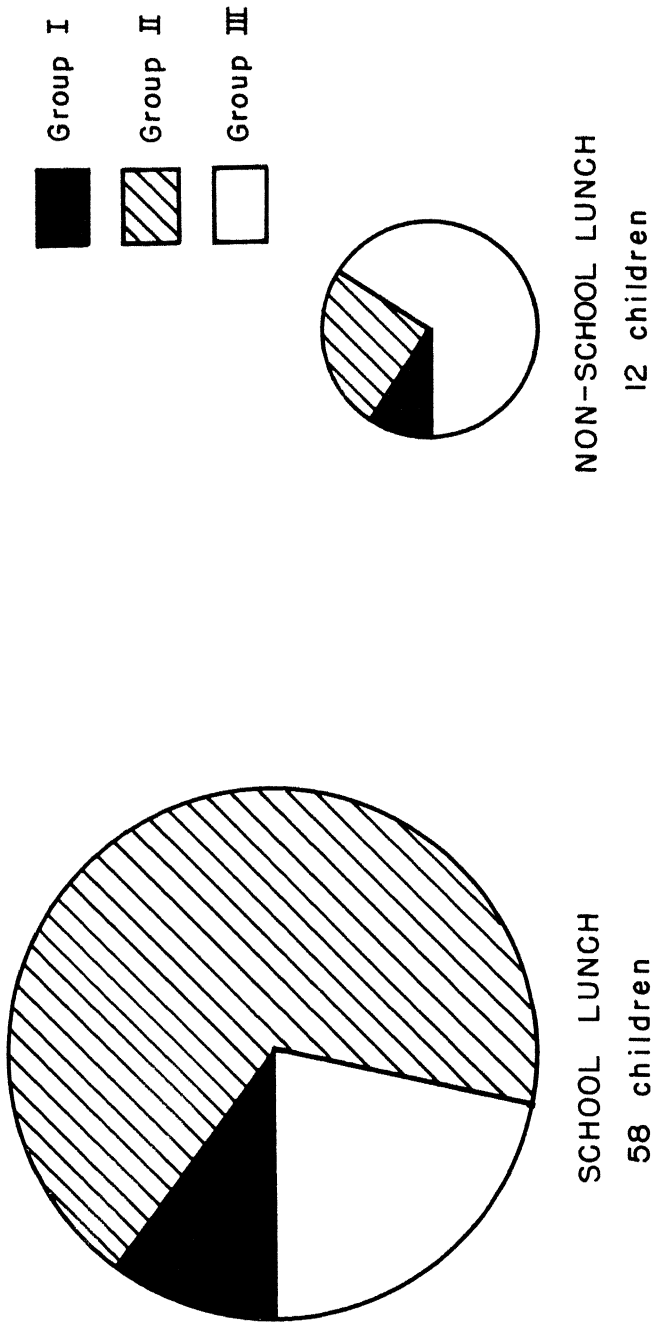

Fig. 2.—Percentage distribution by diet ranking and participation in school lunch for children in period A.

Mid-morning Supplementation

Ascorbic Acid. The children's dietary levels of ascorbic acid tended toward consistent improvement from period A through B'. In fact, practically all of the children met or exceeded their recommended allowances for this nutrient during the supplementation program. The orange juice offered daily at mid-morning as the supplementary source of ascorbic acid was unanimously accepted by the children and, according to the dietary records, nearly two-thirds of them would not have met their recommended allowances without it. In only a few cases during periods B and B' were increases noted in a child's home consumption of foods that were good sources of ascorbic acid.

Slight sex differences were noted in ascorbic acid intake. A greater percentage of the girls than of the boys met or nearly met amounts recommended for this nutrient during periods B and B' (table 2).

Differences in ascorbic acid level among age groups were more readily apparent in period A than in the periods with supplementation. As indicated in table 3, higher percentages of children who were 8 years old at the beginning of the study had mean levels of this nutrient at or above the recommended amounts in all periods than did those who were in the older age groups.

Vitamins A and D. For discussion purposes, the children were distributed among 4 groups according to type of participation in the vitamins A and D supplementation—those who had the supplement (a) at school only, (b) at school plus at home, (c) at home only and (d) never. The relation of the dietary vitamin A value among children in each of these groups to the recommended allowances is shown in table 4.

As the study progressed the percentages of children getting less than 67 percent of their recommended allowances for these nutrients increased among those who received no supplementation. In other words, without supplementation the vitamin A value of the food eaten did not increase sufficiently to keep pace with increases with age in amounts recommended.

Dietary vitamin A values for the 3 periods varied little between sexes. In period A, however, a slightly larger percentage of girls than of boys met their allowances, and a similar percentage fewer girls than boys had less than 67 percent.

In period A, a larger percentage of the 8-year-olds than of the older children met the amounts of vitamin A value recommended (table

Table 2. Percentage distribution of children* by sex in 3 periods among 3 dietary levels of calories and 8 nutrients

SEX	PERIOD								
	A			B			B'		
	Level of NRC Allow.			Level of NRC Allow.			Level of NRC Allow.		
	100%	67-99%	0-66%	100%	67-99%	0-66%	100%	67-99%	0-66%
				VITAMIN A					
Girls	57	32	11	62	30	8	76	19	5
Boys	45	36	18	64	30	6	79	15	6
				IRON					
Girls	49	49	3	30	70	0	22	68	11
Boys	42	58	0	30	55	15	18	61	21
				CALCIUM					
Girls	41	41	19	35	46	19	35	38	27
Boys	42	42	15	52	42	6	33	52	15
				PROTEIN					
Girls	73	22	5	46	51	3	43	43	14
Boys	70	30	0	64	33	3	52	39	9
				CALORIES					
Girls	27	68	5	27	68	5	16	70	14
Boys	21	67	12	21	67	12	6	70	24
				THIAMINE					
Girls	38	62	0	59	41	0	57	35	8
Boys	33	61	6	48	45	6	64	30	6
				RIBOFLAVIN					
Girls	70	24	5	51	46	3	57	30	14
Boys	79	15	6	76	21	3	67	27	6
				NIACIN					
Girls	73	24	3	43	54	3	57	38	5
Boys	58	39	3	39	55	6	48	36	15
				ASCORBIC ACID					
Girls	41	49	11	92	8	0	95	5	0
Boys	30	42	27	85	9	6	88	12	0

* 37 girls -- 33 boys

3); in fact, only 25 percent of the 11-year-olds met the recommended level compared to 73 percent of the 8-year-olds. In B and B' this trend with age continued, although the diets of children in all age groups showed improvement in vitamin A value during these periods. In B' about three-fourths of the subjects were meeting or exceeding their

Table 3. Percentage distribution of children by age in 3 periods among 3 dietary levels of calories and 8 nutrients

AGE	NO. OF CASES	PERIOD A Level of NRC Allow. 100%	67-99%	0-66%	PERIOD B Level of NRC Allow. 100%	67-99%	0-66%	PERIOD B' Level of NRC Allow. 100%	67-99%	0-66%
					CALORIES					
8	11	55	45	0	36	64	0	18	82	0
9	26	19	77	4	27	65	8	8	73	19
10	22	23	68	9	27	64	9	18	55	27
11	8	12	62	25	0	88	25	0	75	25
12	3	0	67	33	0	67	33	0	100	0
					PROTEIN					
8	11	91	9	0	82	18	0	64	36	0
9	26	77	23	0	54	38	8	50	31	19
10	22	73	18	9	50	50	0	45	45	9
11	8	38	62	0	38	62	0	12	75	12
12	3	33	67	0	33	67	0	67	33	0
					CALCIUM					
8	11	55	36	9	55	36	9	36	55	9
9	26	50	31	19	54	27	19	42	31	27
10	22	36	50	14	32	55	14	36	41	23
11	8	25	50	25	25	75	0	0	75	25
12	3	0	67	33	33	67	0	33	67	0
					IRON					
8	11	82	18	0	55	45	0	27	73	0
9	26	42	58	0	35	54	11	27	62	11
10	22	50	45	5	23	77	0	14	59	27
11	8	12	88	0	12	75	12	12	62	25
12	3	0	100	0	0	67	33	0	100	0
					VITAMIN A					
8	11	73	27	0	73	27	0	91	9	0
9	26	58	31	12	77	15	8	77	19	4
10	22	45	45	9	50	45	5	77	14	9
11	8	25	25	50	50	38	12	62	25	12
12	3	33	33	33	33	33	33	67	33	0
					ASCORBIC ACID					
8	11	73	27	0	100	0	0	100	0	0
9	26	31	62	7	92	4	4	96	4	0
10	22	32	41	27	86	14	0	86	14	0
11	8	12	38	50	88	12	0	88	12	0
12	3	33	33	33	33	33	33	67	33	0
					THIAMINE					
8	11	64	36	0	82	18	0	73	27	0
9	26	42	50	8	69	27	4	73	23	4
10	22	32	68	0	36	64	0	45	45	9
11	8	0	100	0	38	50	12	38	38	25
12	3	0	100	0	0	100	0	67	33	0
					RIBOFLAVIN					
8	11	91	9	0	73	27	0	55	45	0
9	26	73	23	4	69	27	4	65	23	12
10	22	82	9	9	59	36	5	68	18	14
11	8	38	50	12	38	62	0	38	50	12
12	3	67	33	0	67	33	0	67	33	0
					NIACIN					
8	11	91	9	0	91	9	0	64	36	0
9	26	73	27	0	42	50	8	54	35	12
10	22	64	32	5	32	64	5	50	36	14
11	8	38	50	12	12	75	12	38	50	12
12	3	0	100	0	0	100	0	67	33	0

Table 4. Percentage distribution of children in 3 periods among 3 levels of NRC allowances for vitamin A value according to participation in the supplement program

SUPPLEMENTATION	PERIOD											
	A* (no supplement)				B (supplement)				B' (supplement)			
	No. of Subjects	Level of NRC Allow.			No. of Subjects	Level of NRC Allow.			No. of Subjects	Level of NRC Allow.		
		100 %	67-99 %	0-66 %		100 %	67-99 %	0-66 %		100 %	67-99 %	0-66 %
At school only	48	46	35	19	48	58	36	6	43	86	14	0
At home** plus at school	7	86	14	0	7	100	0	0	5	80	20	0
At home only**	6	66	17	17	6	83	17	0	9	89	11	0
Never	9	44	44	12	9	44	33	23	13	42	29	29

* No supplement given in this period; figures presented for purposes of comparison.

** Not supplied through supplementation program.

allowance for this nutrient compared to only a half in period A. The percentage of subjects receiving less than 67 percent was reduced by more than half during this time.

National School Lunch Program

In the first period of supplementation (period B) 58 of the 70 children participated regularly in the hot lunches served at school under the National School Lunch Program and 12 did not.[2] In period B' there were 59 participants and 11 non-participants.

Calculated values for nutrients in the school lunches served plus mid-morning orange juice during the 3-day record-keeping periods were at or above the level required by the National School Lunch Program.[3]

Vitamin A. Dietary levels of vitamin A value for children in both groups, school lunch and non-lunch, improved in periods B and B' as reflected by the increased percentages of children meeting at least two-thirds of the NRC allowances. A larger proportion of those who ate the school lunch than of those who did not met or exceeded recommended dietary levels. Of those not eating the lunch during B', however, none received less than 67 percent of the recommended amounts of vitamin A value as contrasted to half of them in this category for period A (table 5 and fig. 3).

Protein. About 70 percent of the children met their recommended allowances for protein in period A as compared to 61 and 47 percent in periods B and B', respectively. More boys than girls had satisfactory dietary levels in comparison to allowances for this nutrient as the study progressed (table 2).

In every period a larger proportion of younger than of older children met or nearly met recommended levels for protein (table 3) and, as the children grew older, the proportion of both sexes who had these amounts decreased consistently (except for the three 12-year-old boys).

Children who ate the school lunch tended to have higher dietary levels of protein than did the other children (table 6). All school lunch participants, in comparison to 5 of 6 of the non-participants, had at least two-thirds of NRC allowances for this nutrient before supplementation.

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[2]Of the 12 children who did not eat the school lunch, 2 went home at noon and 10 carried home-packed lunches. Seven came from 2 families; 3 boys and a girl were in 1 and 2 girls and a boy, in the other. These children did not participate in the school lunch chiefly for financial reasons.

[3]The National School Lunch Program requires that Type A lunches provide a third of the recommended daily allowances for a 12-year-old boy for calories and 8 nutrients.

Table 5. Percentage distribution of children in 3 periods among 3 dietary levels of vitamin A according to participation in school lunch

SCHOOL LUNCH PARTICIPATION	PERIOD											
	A				B				B'			
	Level of NRC Allow.				Level of NRC Allow.				Level of NRC Allow.			
	No. of Cases	100 %	67-99 %	0-66 %	No. of Cases	100 %	67-99 %	0-66 %	No. of Cases	100 %	67-99 %	0-66 %
Participants	58	55	38	7	58	64	31	5	59	79	14	7
Non-participants	12	33	17	50	12	58	25	17	11	64	36	0

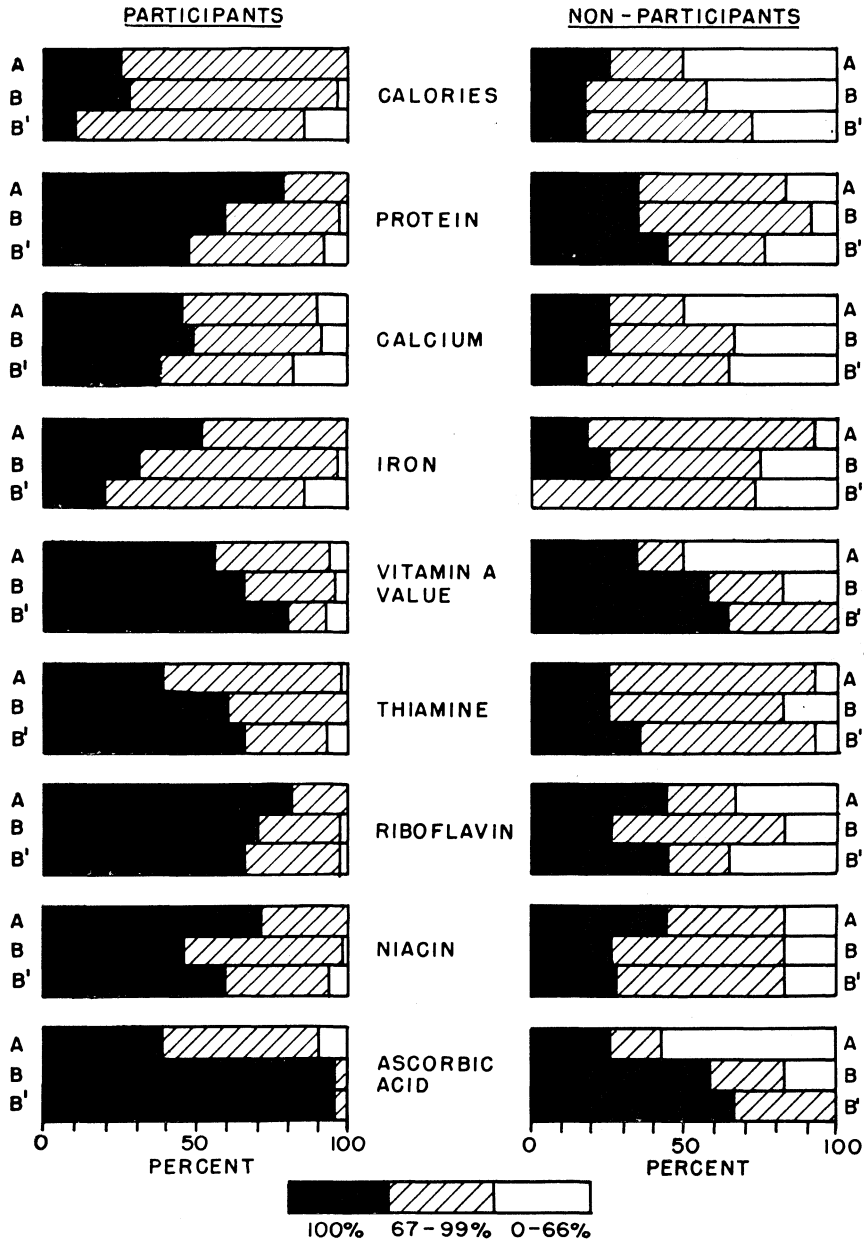


Fig. 3.—Percentage distribution of children's diets in periods A, B and B' among 3 levels of recommended allowances (NRC) for calories and 8 nutrients according to participation in the school lunch.

During supplementation, the percentage of participants getting recommended amounts decreased, with a small percentage getting less than two-thirds of the allowances.

One-third of the non-participants had recommended protein intakes in all periods. The largest percentage of non-participants (33 percent) getting less than two-thirds of the allowances for this nutrient occurred in period B' (fig. 3 and table 6). This substantiates the above statement that, with increasing age of children, percentages meeting allowances decreased. In other words, their intakes did not increase proportionately as NRC recommended allowances rose for succeeding ages.

About half the children in this study maintained a given dietary level in relation to the recommended amounts throughout the 3-year period; 6 percent increased protein intake sufficiently to move to a higher dietary level and 36 percent moved to a lower one. Of the children who shifted to a lower level (from 100 percent or above to 67-99 percent or below 67 percent), all but one moved to the next lower level. Most of the younger children who moved down still had at least 67 percent of their allowances, but many of the older children who had 67-99 percent of their allowances in period A were getting less than 67 percent in B' (table 3).

Calories. According to findings in the first year of the study, many of the children did not meet the recommended allowances for calories. In fact, nearly 70 percent of them were at the 67-99 percent level. Supplementation of the school lunch increased the caloric value of the school meals offered participants but failed to alter the percentage distribution of children among the three levels for calories.

Before supplementation all of the children who ate the school lunch got at least 67 percent of their recommended allowances for calories. Little change in this was noted during the first year of supplementation. During the second year of supplementation, however, fewer met the recommendations and more were in the less than 67 percent category than previously. Of the children who participated in the school lunch program, half had less than 67 percent of the recommended amounts of calories in period A. The situation improved somewhat, due, in some cases, to participation in the Special School Milk Program.

Diets of 69 percent of all subjects did not measure up to amounts recommended for calories at any time during the study. The percentages by which they were low varied greatly. Throughout the study the

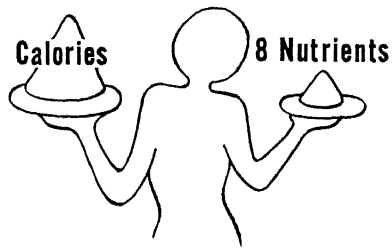
Table 6. Percentage distribution of children in 3 periods among 3 dietary levels of protein according to participation in school lunch and/or Special Milk Program

PARTICIPATION	NO. OF CASES	PERIOD A Level of NRC Allow. 100 %	A 67-99 %	A 0-66 %	PERIOD B Level of NRC Allow. 100 %	B 67-99 %	B 0-66 %	PERIOD B' Level of NRC Allow. 100 %	B' 67-99 %	B' 0-66 %
School lunch participants*	58	79	21	0	59	40	1	50	43	7
Non-participants*	12	33	50	17	33	58	8	33	33	33
School lunch + Special milk**	46				61	39	0	52	41	7
School lunch - Special milk	11				55	36	9	27	64	9
Non-participants + Special milk**	8				38	50	12	50	12	38
Non-participants - Special milk	3				33	67	0	33	33	33

* In periods A and B 58 children ate the school lunch and 12 did not; in B', one child started participating in the school lunch making 59 who did and 11 who did not.

** Special Milk Program was in effect during period B' only. No differentiation is made between number of times per week students participated in the milk program. Frequency varied from once to 5 times per week. Frequency of participation is found in table 8.

energy value of more diets remained in the same category in relation to NRC allowances than was true for any nutrient calculated. Only 4 percent of the diets were shifted to a higher level and 27 percent to a lower level as a result of changes in diet or in recommended allowances. In general, however, as the children grew older, the caloric values of their diets did not increase in proportion to the increases with age in recommended allowances, and boys had slightly lower values in relation to allowances than the girls did for all periods.



Relationship between Caloric Values and Dietary Levels of 8 Nutrients. On the average the children who met their recommended allowances for calories at any one period also met allowances for all or all but one of the nutrients considered. As they received smaller proportions of recommendations for calories, the likelihood of their having recommended amounts of 8 nutrients also decreased. Those children whose caloric levels were 30 percent or more below recommended allowances had approximately 6 nutrients below. The dietary levels of half of these 6 nutrients were at less than 67 percent of the allowances.

Iron. The supplementation program did not aim specifically to increase dietary iron. In period A, all but one child were getting at least 67 percent of recommended allowances for this nutrient and, in fact, 46 percent of the children were meeting or exceeding recommendations. As the study progressed over the 3-year period, the number of children meeting allowances decreased consistently. Variations between sexes were evident at the 2 lower dietary levels (table 2) but not at the 100 percent level.

Forty-three percent of the group did not have recommended amounts of dietary iron in any period compared to 9 percent who did in all periods. The majority of those failing to meet allowances had dietary levels at less than 20 percent below the recommended amount.

Distinct differences were evident in levels of dietary iron between those who participated in the school lunch and those who did not (fig. 3). All of the participants had at least 67 percent of the recommended amounts before supplementation. The proportion of children maintaining this level decreased during the supplementation. Among non-

participants, the percentage getting at least 67 percent of the allowances for iron decreased as the study progressed until none met the allowance at the end of the study.

The pattern for dietary levels of iron in relation to age was similar to that for protein and calcium. In all periods, the larger proportion of the children who failed to meet their recommended allowances for iron were the older children. Also, as children in all age levels grew older, the number meeting their allowances decreased (table 3).

Calcium. No appreciable sex difference in dietary calcium was noted in period A. In B the percentage of boys meeting their recommended allowances increased, accompanied by a decrease in those having less than 67 percent. From B to B' the percentage of boys meeting recommendations for this nutrient dropped again and the difference was absorbed by equal increases in each of the other 2 levels (table 2). The percentages of girls meeting their recommended allowances were the same in B as in B' (35 percent) and somewhat less than in period A (40 percent). A larger percentage of girls was in the 0-66 percent level in B' than in either A or B.

No consistent pattern in dietary level of calcium in relation to age was shown; however, in periods A and B' a larger percentage of younger than of older children met 67 percent or more of their allowances.

Ratings for dietary level of calcium of school lunch participants were similar for periods A and B. In B' the percentage of participants who met their recommended allowances declined accompanied by an increase in those who had less than 67 percent. From A to B the percentage of non-participants who had at least 67 percent of their allowances for calcium increased. In B' the percentage meeting the allowances dropped, with an accompanying increase in the percentage of those who had less than 67 percent. More school lunch participants than non-participants met or nearly met recommended amounts for this nutrient in all periods (table 7 and fig. 3).

Special School Milk Program

In period B' extra milk was available to all children at a reduced price under the Special School Milk Program. The degree of participation in the extra milk program varied and a larger percentage of the girls than of the boys took the milk.

In period B', the lunch participants who also participated in the Special School Milk Program maintained the same level of calcium in their diets as in period B. Among those who did not have the extra milk, the percentage meeting recommended allowances for this nutrient

Table 7. Percentage distribution of children in 3 periods among 3 dietary levels of calcium according to participation in school lunch and/or Special Milk Program **

PARTICIPATION	No. of Subjects	PERIOD A Level of NRC Allow. 100 %	A 67-99 %	A 0-66 %	B Level of NRC Allow. 100 %	B 67-99 %	B 0-66 %	B' Level of NRC Allow. 100 %	B' 67-99 %	B' 0-66 %
School lunch participants*	58	45	45	10	47	45	8	37	46	17
Non-participants*	12	25	25	50	25	42	33	18	42	42
School lunch + Special milk	46				48	45	7	43	40	17
School lunch - Special milk	11				46	36	18	18	64	18
Non-participants + Special milk	8				38	25	38	25	38	38
Non-participants - Special milk	3				0	33	67	0	33	67

* Fifty-eight children ate the school lunch and 12 did not in periods A and B; in period B' the totals were 59 and 11, respectively.

** The Special Milk Program was in effect during period B' only.

decreased by more than half but did not change for those who had less than 67 percent of their allowances (table 7).

Groupings of the children according to frequency of participation in the Special School Milk Program with the percentages in each of 3 dietary levels of calcium, riboflavin and protein in periods B and B' are presented in table 8. For children who had one extra serving or more on at least 3 days per week, percentages meeting the allowances increased in period B'; without the extra milk or with less frequent participation in the program, fewer of the children met the recommended amounts for calcium and more had less than 67 percent.

About half of the group maintained the same level of calcium in relation to recommended allowances throughout the 3 years. By the time the study ended about a sixth of the subjects had moved to a higher level and a fourth of the group, to a lower dietary level than they were in at the start. Not only did the recommended allowances for the children increase as they grew older, but some individuals in the group (41 percent) decreased their actual intake of food containing calcium. Eppright (1) reported similar downward trends in dietary levels of this nutrient among older children. Some in the study, however, had intakes sufficiently high at the start that a slight decrease in consumption did not cause a shift below their recommended allowances.

The use of milk from the Special School Milk Program influenced the dietary levels of nutrients other than calcium. The pattern of riboflavin in the diets, for example, resembled that of calcium except that more of the subjects met or nearly met their allowances for this nutrient than for calcium (table 8).

The recommended allowances for protein were met by more of the children who took advantage of the Special School Milk Program than by those who did not. Without the extra milk however, the majority of the children had at least 67 percent of their allowances for this nutrient.

Table 8. Percentage distribution of children in each of 2 periods among 3 dietary levels of calcium, protein and riboflavin according to frequency of participation in Special Milk Program*

FREQUENCY OF PARTICIPATION	NO. OF CASES	CALCIUM						PROTEIN						RIBOFLAVIN					
		B			B'			B			B'			B			B'		
		Level of NRC Allow.						Level of NRC Allow.						Level of NRC Allow.					
		100 %	67-99 %	0-66 %	100 %	67-99 %	0-66 %	100 %	67-99 %	0-66 %	100 %	67-99 %	0-66 %	100 %	67-99 %	0-66 %	100 %	67-99 %	0-66 %
Daily	17	53	47	0	65	29	6	65	35	0	59	41	0	65	35	0	76	24	0
3-5 times/week	4	25	50	25	50	50	0	50	50	0	50	50	0	75	25	0	100	0	0
2 times/week	17	41	47	12	29	41	29	53	47	0	41	29	29	59	41	0	59	18	23
Occasionally	16	56	31	13	25	44	31	56	38	6	56	38	6	75	19	6	69	25	6
Never	14	36	36	28	13	58	29	50	43	7	28	57	14	57	36	7	29	57	14
No record	2																		

* The Special Milk was available during period B' only. Figures for period B are given for comparison purposes.

DIETARY RATINGS IN RELATION TO OMISSION OF BREAKFAST

According to information obtained from mothers, nearly half of the children (30 of the 70) skipped breakfast either regularly or fairly often. Reasons most commonly given for a child's missing the morning meal were that he (a) was not hungry, (b) either didn't get up in time or allowed himself too little time and (c) didn't like the food offered.

In an over-all ranking of diets of these 30 children throughout the study, 19 were predominantly in group II[4] and 11 in group III[5].

[4]Group II—levels of one or more nutrients at 67-99 percent of NRC recommended allowances.

[5]Group III—levels of one or more nutrients below 67 percent of the recommended allowances.

Calories and the nutrients calcium and iron were most often lower in amounts than recommended for these children.

THE THREE-YEAR PROGRAM

Percentage distribution of diets ranked for period A and for B and B' into groups I, II and III according to levels of nutrients was as follows:

Period	Group I	Group II	Group III
	%	%	%
A	10	60	30
B	13	66	21
B'	4	65	31

Comparatively little change in percentages among the groups occurred during the 3 periods; however, the first year of supplementation (B) appeared to be slightly more effective than the second (B'). Supplementation with ascorbic acid and vitamin A tended to decrease percentages of diets in group III for period B. The increased percentage in group III during B' was due to lower dietary levels in relation to allowances for calories and nutrients other than ascorbic acid and vitamin A value. As pointed out earlier, caloric values below allowances were associated with low dietary levels of some nutrients.

Half of the children's diets continued in the same group for all 3 periods. A larger percentage of these were girls' (58 percent) than boys' diets (43 percent). Seven percent went down from group I to II and 14 percent, from II to III; on the other hand, 13 percent moved up from III to II and 3 percent, from II to I; the remainder of the diets (13 percent) fluctuated among groupings.

Specific nutrients most often below the recommended allowances varied some from period to period. Calories and calcium were low in all 3 periods; in addition, iron was low in B and B'; niacin, in B only; and vitamin A value and ascorbic acid, in period A.

More of the children met their allowances for vitamin A, ascorbic acid and for thiamine in B' than in the previous periods but fewer met their allowances for calories, protein, iron, riboflavin and niacin in both supplementation periods than in the unsupplemented period. As the study progressed, not only did a larger percentage fail to meet their allowances but they did so by a greater margin. By B' more children were in the less than 67 percent dietary level for all nutrients except vitamin A and ascorbic acid than in either of the other 2 periods. Supplementation with ascorbic acid and vitamin A was apparently more successful than with the protein and calcium, possibly because the researchers had better control over the amount and the manner in which the first 2 nutrients were supplied.

In period B' a greater percentage of girls than of boys had at least 67 percent of their allowances for iron, calories and niacin but the reverse was true for calcium, riboflavin and protein. Dietary levels of vitamin A value, ascorbic acid and thiamine were similar for boys and girls. In general, with some modifications, this was the pattern of sex differences in all periods. See table 2.

In all periods, the older the children were or became, the less likely they were to meet their recommended allowances for all nutrients. Some differences were noted, however, in the amount of change among the various age groupings. A larger percentage of the children who were 8 years old at the beginning of the study than of those in any of the other age groups studied met their recommended allowances for calories and each of the 8 nutrients for the periods A, B and B'. As this group of 8-year-olds grew older, dietary levels of ascorbic acid, vitamin A value and thiamine improved and the other nutrients either remained practically the same or decreased. In the 3 periods all of the group of 8-year-olds had at least 67 percent of their allowances for calories and the 8 nutrients except for one child in each period who did not meet this level for calcium.

On the other hand, the children who were 11 years old at the time the study started had the smallest percentage of any age level meeting their allowances. For the most part this continued to be true for the group for all periods in spite of the fact that the increases in recommended allowances for girls per year for calories and 4 nutrients for ages 11 through 14 were less than those for ages 8 through 11.

In both the group of children who ate the school lunch and the group who did not, some children had diets which met or exceeded their recommended allowances for all nutrients in period A. However, of the children in the sample with the poorer diets, the majority were those who did not participate in the school lunch. All of the non-participants received the supplementary source of ascorbic acid and most of them, the vitamin A. In addition, some availed themselves of the extra milk regularly. For those receiving these supplements marked gains were seen in dietary levels of related nutrients in periods B and B'.

Similarly, for all periods a larger percentage of participants than non-participants in the school lunch received at least 67 percent of their allowances for all nutrients. Improvement was noted in dietary values for only ascorbic acid, vitamin A and thiamine from A to B' for both participants and non-participants.

The effect of participation of children in the school lunch on nutritive value of diets has been reported by other workers. Although the manner of evaluation may have been different, the conclusions reached were similar. Moser (10) found that those eating school lunches had better nutrient ratings than those who did not. Clayton and Ullman (8) stated that, although the school lunches served at the time of their study did not meet the high requirements of teen-age children, they were more nearly adequate than box lunches or store lunches. According to Abbott et al. (11) the school lunch offers an effective means for raising the nutritional status of school children. Such a lunch needs to be supervised and planned to take care of known deficiencies, with supplementation as necessary.

SUMMARY

The effectiveness of a supplementary feeding program on general health and growth of 70 children in an Ohio elementary school was studied over a period of 3 years. Three-day records of all foods eaten were kept periodically by the children. Diets were classified into 3 groups according to level of recommended amounts of nutrients supplied as follows: group I, average daily dietary levels of all nutrients at 100 percent or more of the recommended allowances; group II, some nutri-

ents at less than 100 percent but none less than 67 percent of the allowances; and group III, at least one nutrient at less than 67 percent of the allowances.

The 3-year study was divided into 3 periods, A, B and B'. During the first year of the study, period A, existing conditions were recorded and no changes were attempted. According to dietary information obtained from the children in this first year, calcium, vitamin A value and vitamin C were the nutrients most often supplied in meals in amounts lower than recommended by the Food and Nutrition Board of the National Research Council. On this basis, good sources of these nutrients were given to the children at school during the 2 succeeding years, periods B and B'.

In period B more children's diets were ranked in groups I and II than in the other periods. Half of the children's diets were in the same grouping for all periods. More changes in classifications were from group I to II or II to III (became poorer) than in the opposite direction. As the study progressed a decrease was noted in the percentages of children having at least 67 percent of their allowances for most nutrients except for vitamin A, ascorbic acid and thiamine. In these there was continued improvement from period A through B' for all children.

Fewer children met the 100 percent level of recommended allowances for protein, iron, riboflavin and niacin in both periods of supplementation than in the unsupplemented period. Many of the children, as they became older, did not increase their food intake sufficiently to keep pace with the higher recommended allowances.

Specific nutrients the children most frequently had in less than the recommended amounts varied some from period to period; however, lower than recommended dietary levels of calories and calcium occurred most frequently in all periods.

It should be pointed out that approximately 7 out of 10 diets were in groups I and II throughout the study. In general, a greater percentage of girls than boys had at least 67 percent of their allowances for iron, calories, niacin and ascorbic acid but the boys had more calcium, riboflavin and protein. In thiamine and vitamin A value negligible sex differences were found.

As the children grew older the frequency with which they met their allowances tended to decrease. Some age group differences were observed. More of the children who were 8 years old at the beginning of the study than any other age group met or nearly met recommended levels for nutrients.

A larger proportion of children who participated in the school lunch than of those who did not had good diets in relation to recommended allowances. Most of the non-participants did receive the supplementary sources of vitamins A and C with corresponding improvement in dietary level of these nutrients, and the few who received the extra fluid milk frequently from the Special School Milk Program showed improved levels of related nutrients. Otherwise there was little period to period change in diets of the group of non-participants.

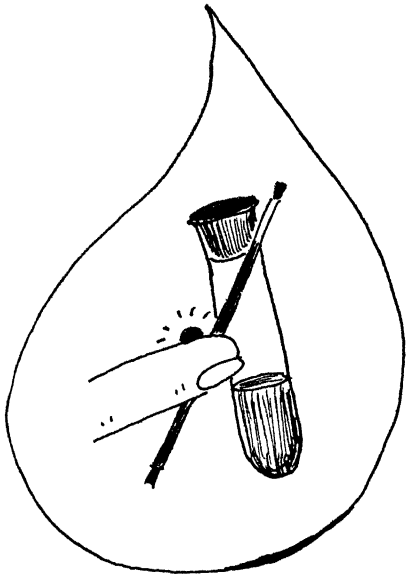
Several factors probably contributed to the fact that the first year of supplementation proved to be more effective than the second. Among these were, first, the extra food provided was sufficient to enable the children to maintain the same level of intake or move to a higher level in B, while in B' the continued increases in recommended allowances were greater than the increases in food eaten; and second, diet records showed that some children actually ate less rather than more as they grew older.

PART II. BLOOD FINDINGS

Serum ascorbic acid values and blood levels of hemoglobin were determined for the 70 children participating in this study. These 2 blood constituents were included in the design of the project because (a) hemoglobin levels may serve as an indicator of general health and nutrition and (b) ascorbic acid, found lower in amounts in many instances than was considered desirable in a previous study of children's diets (1), was to be supplied in the supplementation phase of the longitudinal program. Since serum levels of ascorbic acid normally reflect current dietary intake, response to supplementation with foods rich in this nutrient could be observed through periodic blood analyses.

PROCEDURE

COLLECTION OF SAMPLES



Fingertip blood samples were taken from the children by a medical technician 4 times during the first year of the study at regular intervals in the fall, winter and spring; in the second year, fall and spring samples were obtained; and in the final year, only a spring sample could be collected. Sampling in the latter 2 years was curtailed not by choice but because of lack of technical assistance.

Techniques used in obtaining blood samples were the same as those used in Ohio in a survey of nutrition of 9-, 10- and 11-year-old boys and girls (12). The children were considered to be in a fasting condition with respect to ascorbic acid, having been instructed to have a breakfast selected from the following foods on the mornings blood samples were collected: cereal, milk, toast, jelly.

ANALYSIS OF SAMPLES

Ascorbic Acid. The blood samples to be analyzed for ascorbic acid were collected in capillary tubes, sealed, and refrigerated immediately. The method of analysis used by the laboratory technician was that of Lowry, Lopez and Bessey (13) using 10 mm^3 of serum.

Hemoglobin. Hemoglobin was determined as oxyhemoglobin during the first year of the study, by both the oxyhemoglobin and the cyanmethemoglobin methods in the second year and by the cyanmethemoglobin method in the last year. The 20 mm^3 samples were added

to the dilute ammonia or the cyanide solution as they were taken in the field. These were read within 3 hours in the Evelyn photoelectric colorimeter at the Station Laboratory.

TREATMENT OF DATA

For both hemoglobin and ascorbic acid, blood values were grouped by sex of the children, their age at the outset of the study and dates of sampling. Analyses of variances were made using spring values from each of the 3 periods (periods A, B and B').

Serum ascorbic acid values of less than 0.6 mg per 100 ml are generally considered lower than desirable and lower than 0.3 mg, unsatisfactory (14, 15); values of 0.6 mg or above in this study were, therefore, called satisfactory and those below 0.3 mg, unsatisfactory.

Hemoglobin values in a nutritional survey of Cuban school children, most of whom were 11 to 13 years of age were grouped by Jolliffe et al. (16) by values of 11.0 or less and 12.4 gm hemoglobin or more per 100 ml blood. Bessey and Lowry (15) considered values below 11.0 gm poor and 13.0 or above satisfactory for girls of all ages and boys under age 13. In the present study, therefore, mean hemoglobin values are reported and are discussed in relation to 2 arbitrary levels, 13.0 and 11.0 gm per 100 ml blood.

RESULTS AND DISCUSSION

ASCORBIC ACID

Only values obtained in the spring for serum ascorbic acid were available for comparison in all 3 years of the study (table 9). Among these, sex and age differences were not significant but effects of supplementation were. Greater differences in mean serum ascorbic acid values obtained in the spring occurred between the second and third years of the study (in both of these years supplementation was in progress) than between the first and second years.

Mean values were higher in the spring than in the fall during the first two years (periods A and B). Individual values for 40 percent of the children in the fall of period A and for 30 percent in the fall of period B were below 0.60 mg per 100 ml serum whereas only 20 percent of the children were below the 0.60 mg level in the spring of period A (no supplementation) and for only 1 percent in the spring of period B (after supplementation was begun).

Table 9. Mean ascorbic acid values (mg per 100 ml serum) by sex, age and date of sampling

SEX and AGE	NO. OF CASES	DATE OF SAMPLING						
		Period A				Period B		Period B'
		10-53	12-53	3-54	5-54	4-55	9-55	5-56
Boys								
8	5	1.10	1.44	.86	1.18	.96	.73	1.95
9	14	.91	1.04	1.01	1.08	1.20	.70	1.59
10	6	.65	.75	.88	.80	1.01	.68	1.54
11	5	.63	.60	1.08	.71	.64	.73	1.61
12	3	.64	1.50	.78	.74	.82	.66	2.14
All	33	.82	.99	.96	.96	1.04	.70	1.83
Girls								
8	6	.50	1.14	.90	1.10	1.27	.92	1.98
9	12	.97	.97	1.02	.83	1.11	.99	1.88
10	16	.85	1.08	1.11	.98	.93	.72	1.64
11	3	.56	1.23	1.21	1.00	1.02	.61	1.84
All	37	.82	1.07	1.06	.96	1.05	.83	1.79

Few children had serum ascorbic acid values of less than 0.30 mg per 100 ml, the level generally considered unsatisfactory. Individual values below this level were found in samples for 6 percent of the children in the fall of period A and for 3 percent in the fall of period B.

Throughout the 3-year study 9 percent of the boys and 22 percent of the girls maintained satisfactory serum levels of ascorbic acid. The lowest values of more than half of the children were within the interval of 0.4-0.6 mg per 100 ml serum at least once during the study. All children had satisfactory amounts (0.6 mg or above) in the final period.

HEMOGLOBIN

Hemoglobin values for all children were 11.0 gm or above per 100 ml of blood throughout the study (table 10). Several individual values, however, were below 13.0 gm. Among the boys 21 percent in period A, 27 percent in period B and 6 percent in B' were below this arbitrary satisfactory level. Fewer girls than boys had values for this constituent below 13.0 gm—11 percent of the girls in period A, 3 percent in B and none in B' were below this level.

As with ascorbic acid, hemoglobin values obtained in the spring only were available in all 3 years for comparisons. Among these means those for girls through age 11 at the beginning of the study tended to be higher than for boys (table 10). No girls and only 3 boys were 12 years of age at the beginning of the study. The mean for this small group of

Table 10. Mean hemoglobin values (gm per 100 ml blood) by sex, age at start of study and date of sampling

SEX and AGE	NO.	DATE OF SAMPLING						
		Period A				Period B		Period B'
		10-53	12-53	3-54	5-54	4-55	9-55	5-56
Boys								
8	5	14.4	14.1	14.2	14.4	13.8	14.6	14.2
9	14	14.0	14.0	14.1	14.5	14.0	14.5	14.5
10	6	14.0	13.6	13.7	14.2	13.8	13.3	13.7
11	5	14.1	13.4	14.0	14.6	13.6	14.5	14.9
12	3	14.5	14.5	15.3	15.4	15.9	16.0	17.6
All	33	14.1	13.8	14.1	14.5	14.2	14.4	14.6
Girls								
8	6	14.6	13.8	14.6	14.5	14.5	14.9	15.0
9	12	14.1	14.0	14.6	14.6	14.3	14.9	14.8
10	16	14.0	13.7	14.0	14.8	14.2	14.2	14.7
11	3	14.1	14.1	14.2	14.5	14.4	14.8	14.7
All	37	14.1	13.9	14.3	14.7	14.3	14.6	14.8

boys was markedly higher than that for the preceding age group and became higher with each period. A highly significant difference for age among the boys was shown because of the high values for this small group of 12-year-old boys. Mugrage and Andresen (17) observed an increase in levels of hemoglobin for boys beginning at 13 years and continuing to 17 to 19 years of age.

Means for girls were similar at all ages (table 10) and no significant age differences were revealed. However, the differences among means in the spring of each period were statistically significant for both boys and girls. The means were lower in the spring in period B than in A or B'.

No consistent trend related to season was noted. In period A mean hemoglobin values by sex and by age tended to be slightly lower in December than at the other 3 sampling dates in that year. On the other hand, between the 2 samplings in period B, means tended to be slightly lower in the spring than in the fall.

RELATIONSHIPS BETWEEN BLOOD FINDINGS AND DIET

Ascorbic Acid. As pointed out in the section on dietary findings, period, age and slight sex differences were noted in ascorbic acid intakes. More girls than boys met or nearly met their recommended allowances for this nutrient in all 3 periods. From period to period, means for both diet and serum levels of ascorbic acid increased for both sexes. Further,

higher percentages of children 8 years of age at the start of the study had mean dietary levels at or above the recommended allowances and higher mean serum levels of ascorbic acid throughout the study than did the older children.

According to the dietary data, nearly two-thirds of the children would not have met recommended allowances for ascorbic acid without supplementation during the school year. The effect of the school lunch and of midmorning supplementation on serum levels of this nutrient was reflected by an increase in serum ascorbic acid values from fall to succeeding observations in the school year.

Over half of the children not participating in the school lunch (5 boys and 2 girls of the 12) and slightly more than a third of those who did (8 boys and 12 girls of the 58) had individual serum ascorbic acid values at between 0.3 and 0.6 mg per 100 ml at the beginning of the study. Means for period A for all but one of these children not eating the school lunch and for 2 who did eat it, however, were 0.6 mg or above. All children received orange juice on school days during periods B and B' (the periods of supplementation) and by the end of the study all children, regardless of participation in the school lunch, had serum levels of ascorbic acid well above the level of 0.6 mg per 100 ml generally considered satisfactory.

Hemoglobin. Of the nutrients studied, dietary protein and iron were most likely to be associated with hemoglobin levels in blood. As discussed in Part I of this report, no specific efforts were made in this study to raise the level of iron in the children's diets. Extra protein-rich foods were supplied, however, and as protein intake rose due to larger servings and/or more frequent use of meat, moderate increases in dietary levels of iron would be expected due to the presence of this mineral in meats.

About equal percentages of boys and girls met the recommendations for iron, but more boys than girls had recommended amounts of protein. As the study progressed from period to period and ages of the boys and girls increased, recommended allowances for protein and iron increased but intake did not keep pace. In spite of this, the hemoglobin levels of the children tended to rise. None had hemoglobin values lower than 11.0 gm per 100 ml blood; less than 16 percent had values lower than 13.0 gm in any period; and by the end of the study only 3 percent of the children had less than the level considered satisfactory (13.0 gm per 100 ml).

Children who ate the school lunch tended to have higher dietary levels of protein and iron than did those who did not participate (figure

3, p. 22). None of the girls eating home-packed lunches had individual or mean hemoglobin values of less than 13.0 gm per 100 ml. Individual values for 5 of the 7 boys not eating the school lunch, on the other hand, were between 11.0 and 13.0 gm per 100 ml blood at least once during the three periods but all but 2 of these boys had mean values above this range in all periods.

COMPARISONS BETWEEN MASS SURVEY AND LONGITUDINAL FINDINGS

A survey of the nutrition of 710 Ohio school children 9 through 11 years of age during 1948-51 (1, 12, 18) was a forerunner of the longitudinal study reported herein. Ages of the children included in the two groups were similar at the outset of the longitudinal study and findings from initial blood analyses for hemoglobin and serum ascorbic acid could be compared with those from the former study.

Ascorbic Acid. The mean serum ascorbic acid value for the 9-, 10- and 11-year-old children in the mass survey in Ohio was 0.88 mg per 100 ml serum and in the longitudinal study for children of comparable ages, 0.82 mg. Both of these means would be generally considered "good" (15).

Ranges in means, disregarding sex and age, were 0.78-0.97 mg per 100 ml serum in the former and 0.56-0.97 mg in the latter study. In both the mass survey and the longitudinal study, 9- and 10-year-old girls had higher mean values than did the boys, but at age 11 mean values for boys surpassed those for girls.

In both studies a slight trend toward lower ascorbic acid values with increasing age was noted. This trend could not be observed for an age group over a period of time in this longitudinal study because of the effect on serum levels of supplementation of diets with a rich food source of ascorbic acid.

Hemoglobin. Range in hemoglobin means for age and sex groups in the mass survey was 12.9-13.2 compared to 14.0-14.6 gm per 100 ml at the first sampling in the longitudinal study. By Bessey and Lowry classifications these values would be termed "fair" to "good" and "excellent", respectively. In neither of these studies were sex differences statistically significant for children of comparable ages. In the former study, age differences were found, however; 11-year-olds had significantly higher hemoglobin levels than did either 9- or 10-year-olds. In the latter study means were significantly higher than for other age groups for a small group of 12-year-old boys included in the analysis. Boys tended to have slightly higher hemoglobin values than girls in the mass survey whereas the reverse was found in the longitudinal study.

At the final blood analysis in the longitudinal study, age means for hemoglobin varied from 13.7 to 14.9 and 14.7 to 15.0 gm per 100 ml for the boys and girls, respectively, who had been from 9 to 11 years of age at the start but were now slightly more than 2½ years older. Disregarding sex, the means ranged from 13.7 to 15.0, representing considerably wider variation with increased age. For the small group of boys 12 years of age at the outset, the final mean hemoglobin value was considerably higher than for other groups—17.6 gm per 100 ml blood.

SUMMARY

Serum ascorbic acid values and hemoglobin were determined from fingertip blood samples for the 70 children participating in the longitudinal study. Only samples taken in the spring were available in each of the 3 years of the study for long-term comparisons.

For ascorbic acid, sex and age differences were not significant but effects of supplementation were. Mean values were higher during supplementation than before and were higher in the second year of the supplementation than in the first.

Few individual ascorbic acid values were considered "unsatisfactory"; i.e., were lower than 0.3 mg per 100 ml serum. The few that were below this level occurred in fall samples before the supplementation program had begun for the school year. Nine percent of the boys and 22 percent of the girls maintained "satisfactory" serum levels of ascorbic acid (0.6 gm per 100 ml serum or above) throughout the 3-year study. By the end of the study all values were well above 0.6 mg.

Mean serum ascorbic acid values for 710 Ohio children 9, 10 and 11 years of age in the mass survey were similar but slightly higher than the first values obtained in this longitudinal study—0.88 mg compared to 0.82 mg per 100 ml.

None of the children had "unsatisfactory" hemoglobin values (less than 11.0 gm per 100 ml of blood) durng this study although several individual values were below 13.0 gm, the "satisfactory" level.

Analysis of variance revealed no significant differences among the girls due to age. Means for periods, however, were significant for both sexes; they were lower in period B than in A or B'. No explanation on the basis of dietary iron and protein was found for this low in period B; the percentage of children meeting the RDA declined from period A through B' and the percentage of those getting less than 67 percent of RDA for these nutrients tended to increase. A highly significant difference for age among boys was found because of high values for a small group of 12-year-olds.

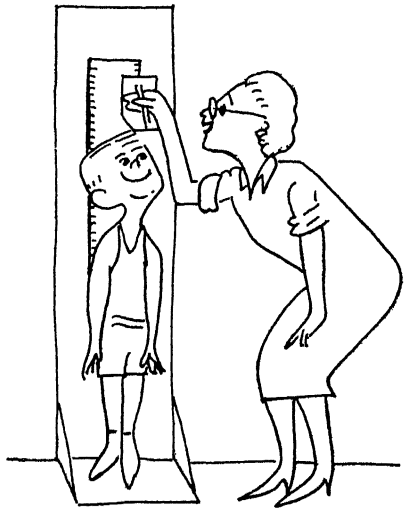
At the prevailing dietary level of protein and iron in this study, hemoglobin values appeared unaffected by moderate increases or decreases in intake of these nutrients. Although protein and iron intakes for many children did not keep pace with recommended allowances as ages increased during the study, hemoglobin values for the children tended to rise slightly.

Mean hemoglobin values were higher at the first analysis in the longitudinal study than in the previous mass survey; the range in means was 14.0-14.6 gm compared to 12.9-13.2 gm per 100 ml blood. Boys tended to have slightly higher hemoglobin values than girls in the mass survey but the reverse was found in the longitudinal study.

PART III. PHYSICAL MEASUREMENTS

PROCEDURE

Physical measurements of the children were recorded at fairly regular intervals during the school years from 1953 through 1956. All were made in mornings by standard procedures by the same person throughout the study.



Height was taken while a child stood in a prescribed stance against a support perpendicular to the floor. To this was attached a tape graduated in inches and centimeters. A right angle leveler was placed against the support and rested lightly on the head of the child. The reading was recorded to the nearest tenth of a centimeter and converted to inches at a later date.

Weight was taken in pounds and ounces using a platform scale. The children were weighed in underwear and socks. If occasionally an outer garment was not removed an allowance was made for it. Chest and bi-iliac widths were obtained to the nearest tenth of a centimeter with calibrated sliding calipers. These physical measurements were compared with the commonly used standards of Baldwin and Wood (19), Pryor (20) and Wetzel (21).

Mean weight and height of each child were calculated for each age from measurements taken during the year the child was that age. The number of measurements in a year for each child varied due to frequency of measuring, the child's birth date and number of absences from school. In some instances only one or 2 measurements for a child were available for a particular year of age.

The growth records for the 70 children in this study are discussed herein from 2 aspects. From the longitudinal viewpoint, the progress of each child from year to year during the study was of primary concern. Secondly, progress of children of the same age were compared. In these comparisons, numbers of cases considered at the different ages varied due to absences, differences in birth dates and in numbers of children at different ages at the beginning of the study.

RESULTS AND DISCUSSION

COMPARISONS WITH COMMONLY USED GROWTH STANDARDS

Baldwin-Wood and Pryor

In comparing measurements of these children with the Baldwin-Wood and Pryor standards, weights were classified according to percentage of variation from expected weight using arbitrary intervals of 10 percent. Measurements within ± 9 percent of the standard were considered normal; +10 percent or more, heavy; and —10 percent or below, thin (22). The distributions by sex and date of measurement are presented in table 11.

Girls. About 50 percent of the girls' weights were within the normal range by Baldwin-Wood standards. In 1953 only 11 percent were above normal, while the remainder (41 percent) were below. From 1953 to 1957 the percentage below normal tended to decrease and the percentage above, to increase (fig. 4).

By the Pryor standard about 10 percent more were in the normal group and fewer were in the thin group than by the Baldwin-Wood standard. Greater variation in distribution among intervals from time to time occurred with Pryor than with Baldwin-Wood standards. When just height, weight and age were considered, the children appeared to grow at a proportional rate maintaining a fairly constant degree of variation from the standard. When measurements of chest and bi-iliac (for Pryor standard) were taken into account, changes in body structure characteristic of this age level in girls amounting to only small percentage differences often accounted for shifts from one interval to another (23). In most cases the variations from the Pryor standard were within 10 to 15 percent.

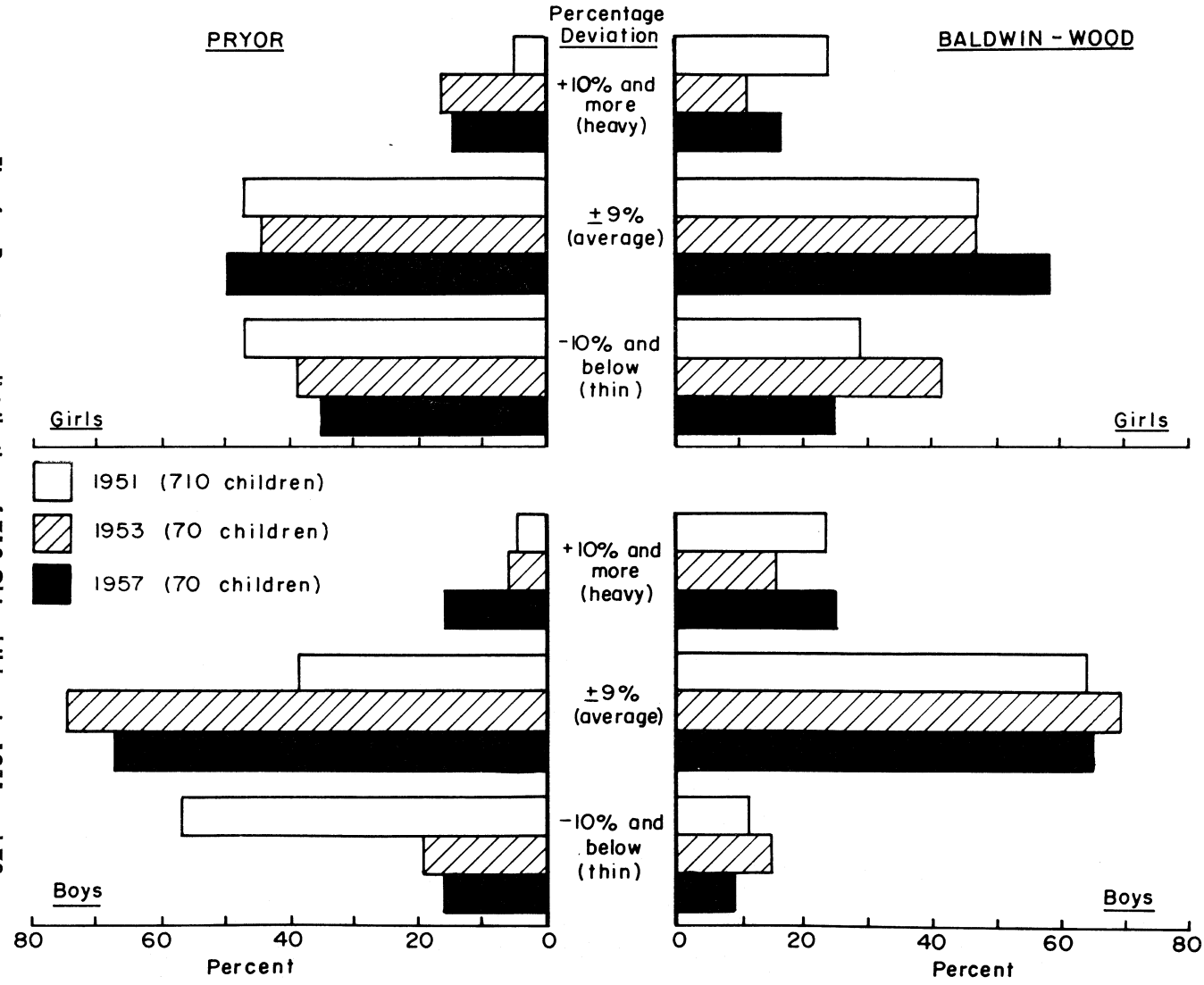


Fig. 4.—Percentage distribution of 710 Ohio children in 1951 and 70 Ohio children in 1953 and 1957 by sex and body build according to 2 standards.

Table 11. Distribution of girls and boys among 3 groups by Pryor and Baldwin-Wood standards and date of measurement

	BOYS							GIRLS						
	NO.	+10% and Above		± 9%		-10% and Below		NO.	+10% and Above		± 9%		-10% and Below	
		Pryor	Baldwin-Wood	Pryor	Baldwin-Wood	Pryor	Baldwin-Wood		Pryor	Baldwin-Wood	Pryor	Baldwin-Wood	Pryor	Baldwin-Wood
		No.	No.	No.	No.	No.	No.		No.	No.	No.	No.	No.	No.
10/20/53	33	5	2	23	25	5	6	36	4	6	17	16	15	14
3/8/54	32	6	1	24	26	2	5	37	5	5	19	23	13	9
9/14/54	32	5	3	22	22	5	7	37	8	3	15	22	14	12
1/13/55	31	7	0	20	25	4	6	37	6	3	18	23	13	11
5/12/55	33	9	1	22	22	2	10	35	7	4	14	20	14	11
9/20/55	32	8	3	20	26	4	3	37	7	3	18	23	12	11
12/15/55	32	9	3	20	21	3	8	34	7	4	16	25	11	5
4/24/56	32	8	2	21	27	3	3	37	8	4	18	26	11	7
9/18/56	33	8	1	21	25	4	7	37	7	5	18	22	12	10
4/30/57	32	8	5	21	22	3	5	37	6	6	22	18	9	13

Boys. About 65 percent of the boys were classified in the normal range throughout the study by the Baldwin-Wood standard. At the beginning of the study the percentages above and below this category were about equal, but by 1957 the percentage below was smaller than that above (fig. 4).

By the Pryor standard more boys were classified in the normal category (±9 percent) than by Baldwin-Wood (table 11). A slightly larger percentage was below rather than above normal in 1953 as well as at most measurement dates in the interim between 1953 and 1957, but percentages above and below were equal on the final measurement date. As with girls' measurements, greater fluctuations occurred for boys among intervals from one date to another with Pryor than with Baldwin-Wood standards.

All. By Baldwin-Wood, the majority (63 percent) of the children (19 boys and 25 girls) started and ended the study in the same percentage interval of variation from expected weight. At the end of the study 9 percent (2 boys and 4 girls) were classified as thinner, and 29 percent (12 boys and 8 girls) were classified as heavier than at the start. With Pryor, more fluctuations among intervals were noted for both sexes; 43 percent of the children maintained the same degree of variation from the standard, 31 percent moved toward the heavy side and 20 percent tended toward thin. Six percent of the children could not be categorized because figures corresponding to their measurements for age were not included in the Pryor tables.

Distributions of the children in 1953 and 1957 as normal, thin or overweight by both Baldwin-Wood and Pryor standards were compared with the distribution of a group of 710 Ohio children from a previous study (22). The groups of boys and girls in all 3 years had more nearly similar distribution patterns by Baldwin-Wood than by Pryor groupings (fig. 4). The pattern for the boys showed slightly less variation than did that for the girls. According to Pryor more of the boys in the present study were classified as normal in size than in the earlier study and fewer as underweight. By the same standards, more girls were heavier in both 1953 and 1957 than in the previous study.

Wetzel

The Wetzel Grid provides for a visual record of the individual child's growth progress plotted from age, weight and height data. Points plotted on the grid fall into channels which Wetzel has designated as follows: A_4, obese; A_3A_2, stocky; A_1MB_1, average or medium; B_2, slender; and B_3B_4, very slender. An auxodrome panel reflects the speed

of development by showing the relation between size and age. Appropriate points are plotted on a normal panel showing 2, 15, 67, 82 and 98 percentiles for the general population. Children who have attained the 67th percentile are considered as normal; above this, 15 and 2 percentiles, as advanced; and below, 82 and 98 percentiles, as retarded. The children in this study were grouped according to these classifications.

Physique Channels. Distributions among the various physique channels on the dates measurements were recorded for girls and boys are presented in table 12. Although there were changes from one date to another, about half of the total group was in the medium channel during the 4-year period. Children who changed channels tended to move toward the stocky side.

Differences in distribution of girls and boys among channels were noted. In general, a higher percentage of boys (60 percent) than of girls (40 percent) were in the medium channel. Figure 5 was developed to show the number of children changing channels and the direction of change during the 4-year period. For example, it shows that 14 boys

Table 12. Distribution of girls and boys among Wetzel channels by date of measurement

DATE	GIRLS NO. OF CASES	GIRLS Channels A_4	A_3A_2	A_1MB_1	B_2	B_3B_4	BOYS NO.	BOYS Channels A_4	A_3A_2	A_1MB_1	B_2	B_3B_4
		No.	No.	No.	No.	No.		No.	No.	No.	No.	No.
10/20/53	36	3	1	15	7	10	33	0	2	22	7	2
3/8/54	37	3	1	17	7	9	32	1	5	20	5	1
9/14/54	37	3	3	16	2	13	32	0	3	19	7	3
1/13/55	37	3	2	16	4	12	31	0	5	20	5	1
5/12/55	35	4	2	14	5	10	33	0	5	20	6	2
9/20/55	37	4	2	17	3	11	32	1	5	17	7	2
12/15/55	34	4	2	13	7	8	32	2	5	18	6	2
4/24/56	37	4	4	14	8	7	32	3	4	20	4	1
9/18/56	37	5	2	15	7	8	33	3	5	17	6	2
4/30/57	37	4	2	21	2	8	32	3	5	17	5	2

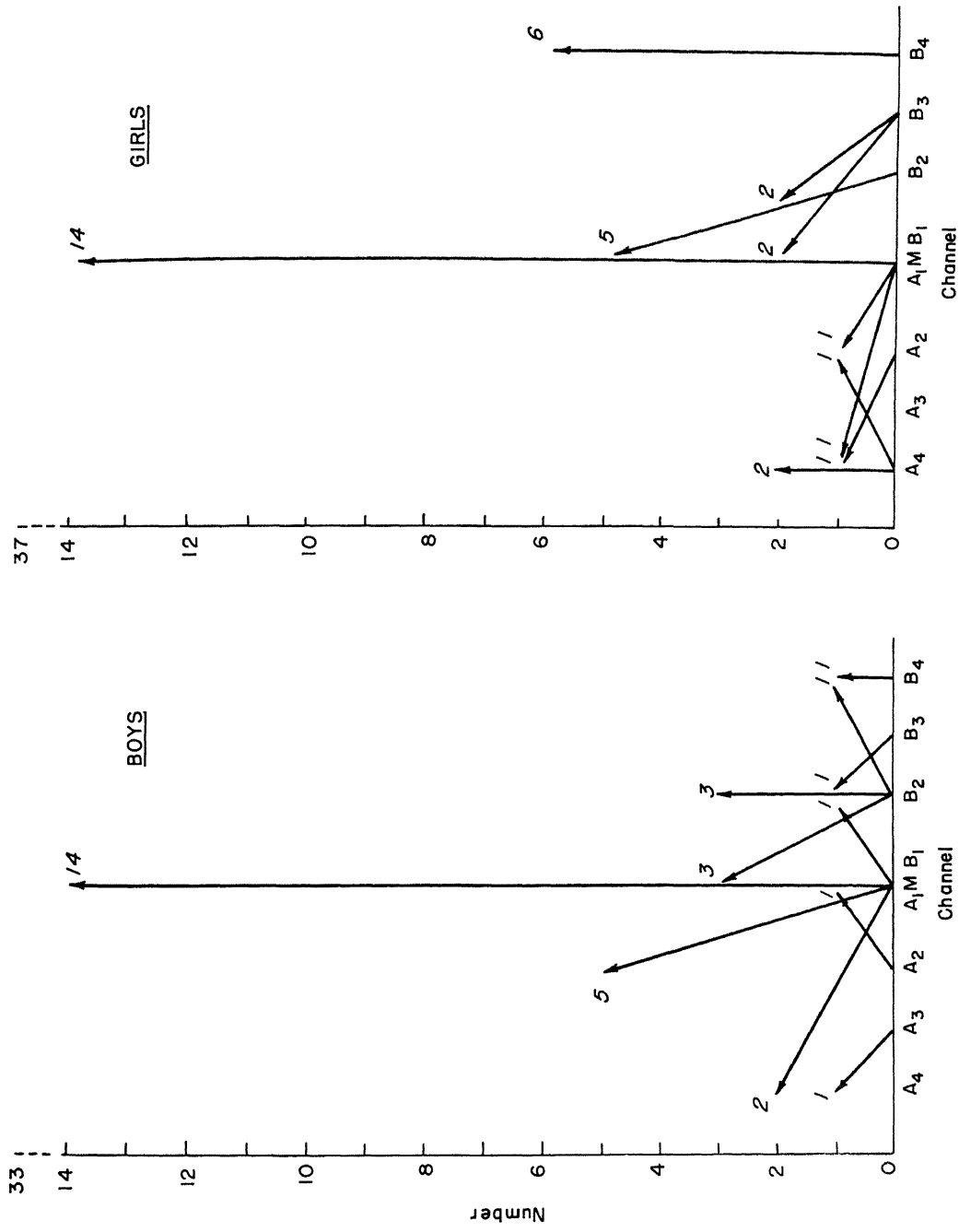


Fig. 5.—Distribution of 33 boys and 35 girls among Wetzel Grid channels showing direction of change in physique, if any, during the period from 1953 to 1957.

and 14 girls remained in the medium channel (A_1MB_1) and 6 girls and 1 boy, in B_4; 2 girls changed from B_3 to B_2 and 2 others, from B_3 to medium (A_1MB_1). One noticeable difference in sexes is shown—a relatively high proportion of girls were thin or very thin and continued in these categories.

Greater percentages of the children who were 8 years old at the beginning of the study were classified as average than was true for any other age group. For the 9-, 10- and 11-year-old groups (table 13) the percentages of children in this channel (A_1MB_1) decreased with increase in age. In all age groups, however, the percentages in the medium channel remained fairly constant for the specific age for the entire period of the study.

Comparisons with Other Ohio Studies. Distribution of the group among channels in 1953 and 1957 was compared with distribution of a group of 710 Ohio children reported by Patton et al. (22) and with a study done by Wetzel (24) of 2093 Ohio children. Similarity in distribution among the channels for the 4 groups can be seen in figure 6.

Development Levels. In the schedule of physical development attained for age, as worked out by Wetzel, slightly larger percentages of girls than of boys were rated as advanced in both 1953 and 1957 (table 14). In 1953 about half of the girls compared to about a fourth of the boys were in the advanced group. Fewer girls, however, were in the advanced category in 1957 than in 1953. The opposite was true for boys. In 1957 percentages of boys and of girls were about equally distributed among 3 groups—advanced, normal and retarded.

Comparisons of records of children in this study with those in a pilot study (9) showed placement in auxodrome to be almost identical in both studies. In the pilot study 26 percent were in percentile 82 and 5 percent, in 98 compared to 21 and 10 percent, respectively, in these categories in the present study.

A child's physical status, Dr. Wetzel states, is not evaluated by channel alone (24). The combination of channel and auxodrome placement gives a more nearly accurate estimation of growth. In table 15, distribution of the children by auxodrome percentile and physique channel is shown for the beginning and end of the study. About 50 percent of the children were classed as well-developed (Group II) in both years, but a slightly higher percentage of boys than of girls were thus classified in both 1953 and 1957. These findings were similar to those recorded for Ohio children in a survey of school children in Kansas, Iowa and Ohio (18).

Table 13. Distribution of children by age among Wetzel physique channels on specified dates

DATE	NO. OF CASES	CHANNELS									
		A_4		A_3A_2		A_1MB_1		B_2		B_3B_4	
		No.	%	No.	%	No.	%	No.	%	No.	%
8-year-olds											
10/21/53	11	0	0	0	0	9	82	2	18	0	0
10/12/54	10	0	0	0	0	9	90	0	0	1	10
10/19/55	11	0	0	1	9	8	73	2	18	0	0
9/18/56	11	0	0	1	9	8	73	2	18	0	0
4/30/57	11	0	0	1	9	10	91	0	0	0	0
9-year-olds											
10/21/53	26	1	4	2	8	15	58	4	15	4	15
10/12/54	26	1	4	2	8	15	58	3	12	5	19
10/19/55	26	2	8	2	8	14	54	3	12	5	19
9/18/56	26	3	12	3	12	12	46	3	12	5	19
4/30/57	25	2	8	2	8	14	56	2	8	5	20
10-year-olds											
10/21/53	20	2	10	0	0	9	45	5	25	4	20
10/12/54	21	2	10	2	10	9	43	4	19	4	19
10/19/55	21	3	14	1	5	10	48	2	10	5	24
9/18/56	21	4	19	1	5	7	33	6	29	3	14
4/30/57	21	4	19	1	5	10	48	3	14	3	14
11-year-olds											
10/21/53	9	0	0	1	11	2	22	2	22	4	44
10/12/54	9	0	0	1	11	3	33	2	22	3	33
10/19/55	9	0	0	2	22	3	33	2	22	2	22
9/18/56	9	1	11	1	11	3	33	2	22	2	22
4/30/57	8	1	12.5	1	12.5	3	38	2	25	1	12.5

Table 14. Auxodromic schedule of development attained by boys and girls in 1953 and in 1957

LEVEL OF DEVELOPMENT	AUXODROME PERCENTILE	1953				1957				1953		1957	
		Boys		Girls		Boys		Girls		Total		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Advanced	02	0	0	5	14	0	0	7	19	5	7	7	10
	15	8	24	12	32	10	30	6	16	20	29	16	23
Normal	67	15	45	14	38	13	39	12	32	29	41	25	36
Retarded	82	7	21	4	11	5	15	10	27	11	16	15	21
	98	3	9	2	5	5	15	2	5	5	7	7	10

Table 15. Classification of children in 1953 and 1957 by Wetzel physique channels and auxodrome percentiles

*CLASSIFICATION	PHYSIQUE CHANNEL	AUXODROME PERCENTILE	1953				1957				1953		1957	
			Boys		Girls		Boys		Girls		Total		Total	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
I	A_4	67 to 2	0	0	3	8	3	9	4	11	3	4	7	10
II	B_1 to A_3	67 to 2	19	58	15	49	17	52	17	46	34	49	34	49
III	B_1 to A_3	98 to 68	5	15	2	8	6	18	6	16	7	10	12	17
IV	B_2 to B_4	67 to 2	4	15	13	27	4	12	4	11	17	24	8	11
V	B_2 to B_4	98 to 68	5	12	4	8	3	9	6	16	9	13	9	13

* I - Obese
II - Good physique and good growth
III - Good physique but slow growth
IV - Thin body build but good growth
V - Thin body build and slow growth

AVERAGE HEIGHTS AND WEIGHTS OF OHIO CHILDREN

Mean heights and weights for girls were greater than for the boys from ages 8 through 13 (fig. 7 and 8); in fact, those for girls at ages 8 to 12 were almost identical to those for boys a year older.

Averages of physical measurements of 9-, 10- and 11-year-olds in the present study were compared with mean weights and heights of boys and girls of the same ages from studies done in 1939 and 1951 (22). Values for the girls in 1951 and the present group were almost identical (table 16); however, standard deviations for the latter were slightly larger.

Figures for the boys in 1939 and in the present report were more nearly alike than were those for 1951 and the present study. Standard deviations of means were smaller for boys than for girls. Since girls usually start to mature earlier than do boys, more of the girls than boys may have been starting into the rapid spurt of growth characteristic of pre-adolescence.

Because of a wide span in weights of children at given ages, the median as well as the average was figured. Average weights for girls exceeded the medians at all ages. For boys the average was slightly more than the median at all ages except 10, and differences between the medians and the average weights were less for boys than for girls. Medians and averages for height were in closer agreement than for weight for both sexes; differences were negligible.

COMPARISONS WITH STUART-MEREDITH 50TH PERCENTILES

Median heights and weights for the girls were compared with Stuart and Meredith 50th percentiles (25) (fig. 9 and 10). These were similar up to 14 years; at this age medians for both height and weight were lower than Stuart and Meredith values. For the boys, Stuart and Meredith 50th percentiles for height and weight were slightly above the middle values, except for weights at 13 and 14. These were the same as the 50th percentiles (fig. 11 and 12).

Mean gains in height and weight for both sexes were compared with expected gains.[6] Actual weight gains for the girls 8 to 11 years old were greater than the expected (fig. 13). They reached a peak at age 11-12, a year ahead of and lower than the expected.

Expected height gains exceeded actual gains at all ages except 10-11. The peak for the actual increase occurred at 10-11, two years ahead of the expected, declined slightly from 11-12, and then dropped

[6]Expected gains were calculated from values given by Watson and Lowrey (25, pp. 50-53).

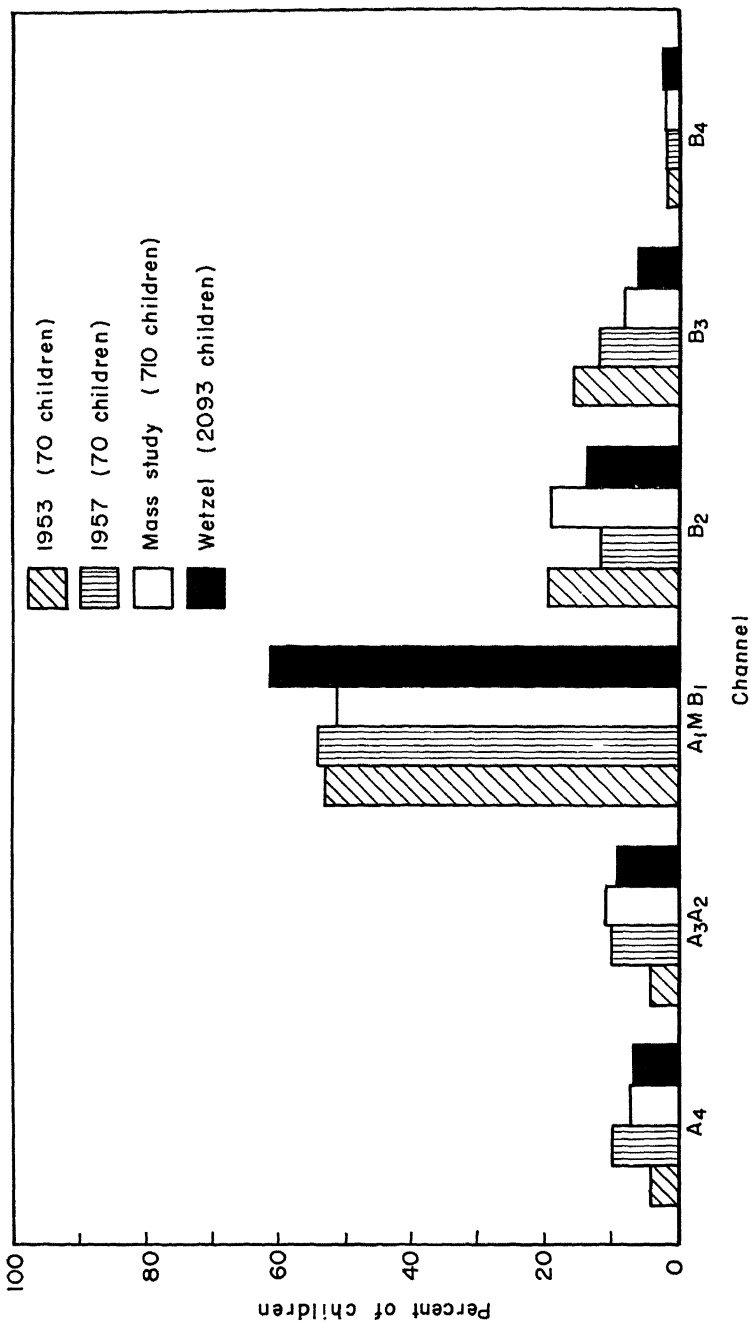


Fig. 6.—Distribution by physique channels of children in the present study (1953 and 1957), in the mass study and in a Wetzel study.

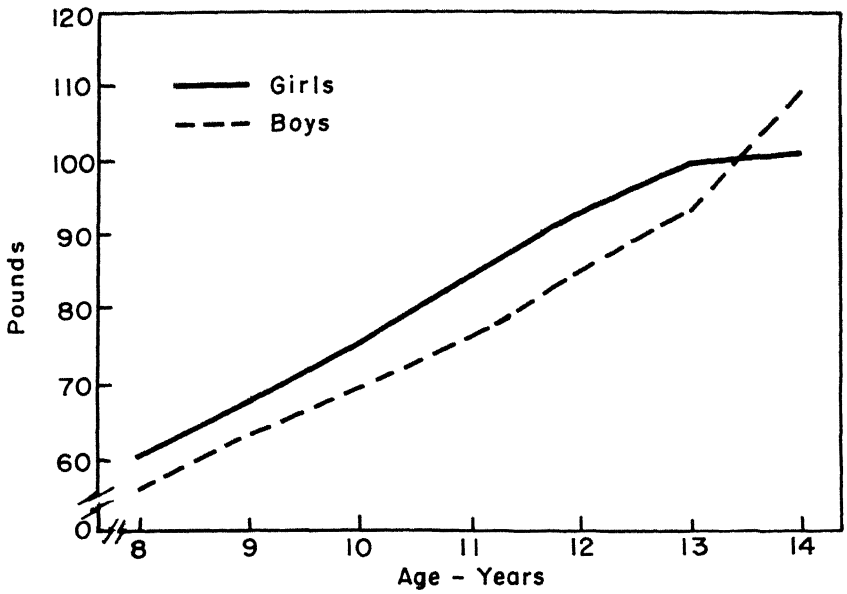


Fig. 7.—Mean weights of boys and girls at ages 8 to 14

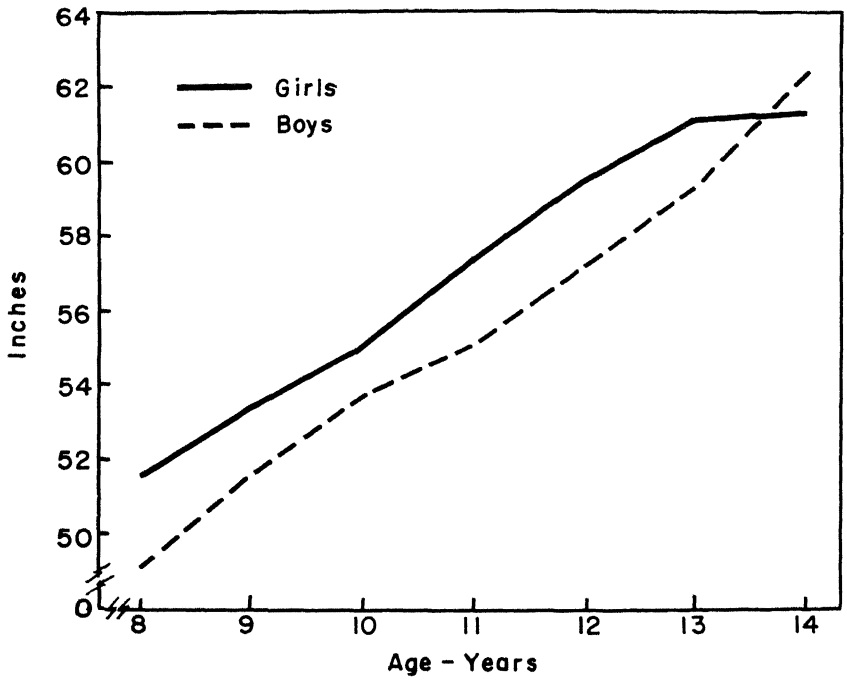


Fig. 8.—Mean heights of boys and girls at ages 8 to 14.

Table 16. Body measurements of Ohio children in 1939, 1951 and 1953-57

MEASUREMENTS	BOYS					
	NO. OF CASES	9-year-olds	NO. OF CASES	10-year-olds	NO. OF CASES	11-year-olds
1939 Av. Wt. (lb.)	576	63.59 ± 9.83	581	69.65 ± 10.96	606	75.51 ± 12.22
1951 Av. Wt.	100	70.00 ± 12.19	140	76.60 ± 14.72	115	83.60 ± 17.45
Present study	18	63.40 ± 7.11	24	69.90 ± 9.41	29	76.40 ± 11.98
1939 Av. Ht. (cm.)	576	133.41 ± 6.52	581	138.20 ± 6.38	606	142.34 ± 6.79
1951 Av. Ht.	100	137.00 ± 4.93	140	142.00 ± 7.02	115	145.00 ± 6.71
Present study	18	131.20 ± 5.75	24	136.30 ± 6.03	29	140.40 ± 6.55
	GIRLS					
1939 Av. Wt. (lb.)	328	62.48 ± 11.19	311	68.42 ± 12.72	606	75.64 ± 12.83
1951 Av. Wt.	96	67.30 ± 13.31	151	76.30 ± 16.32	108	85.80 ± 19.23
Present study	18	67.80 ± 16.33	34	75.80 ± 19.21	37	84.50 ± 23.68
1939 Av. Ht. (cm.)	328	131.98 ± 6.31	311	136.93 ± 6.63	606	142.55 ± 7.05
1951 Av. Ht.	96	136.00 ± 6.48	151	141.00 ± 6.76	115	147.00 ± 7.35
Present study	18	135.60 ± 6.27	34	139.70 ± 7.23	37	145.80 ± 8.27

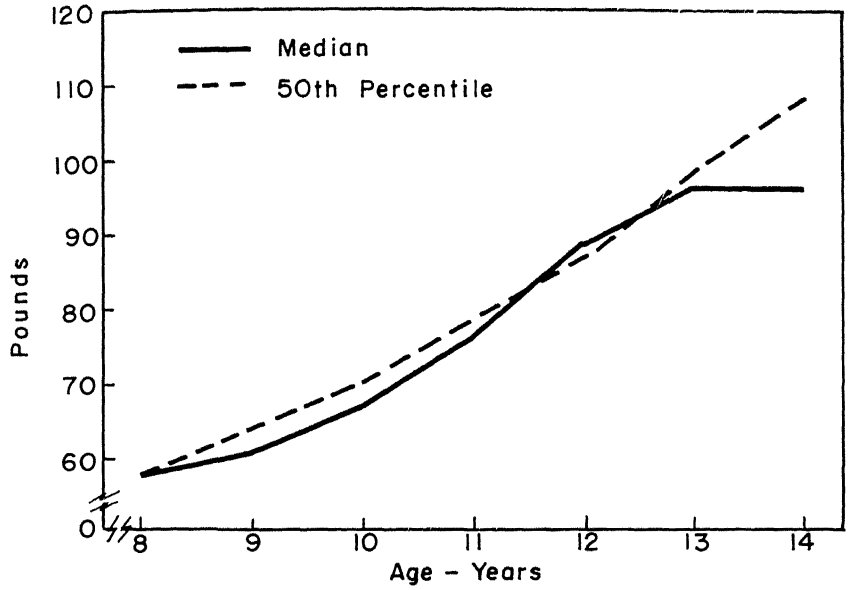


Fig. 9.—Median weights for girls and Stuart and Meredith 50th percentiles at ages 8 to 14.

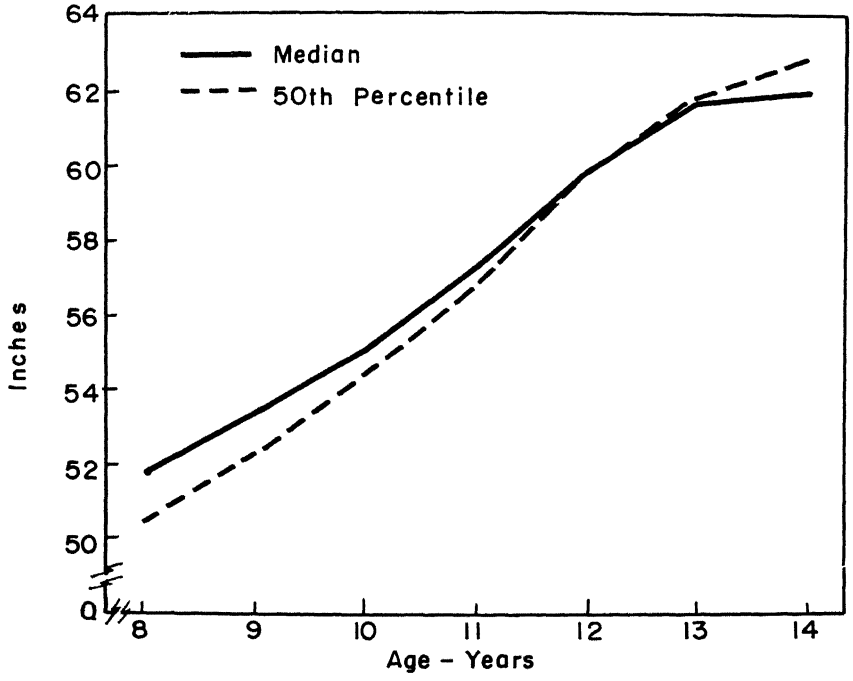


Fig. 10.—Median heights for girls and Stuart and Meredith 50th percentiles at ages 8 to 14.

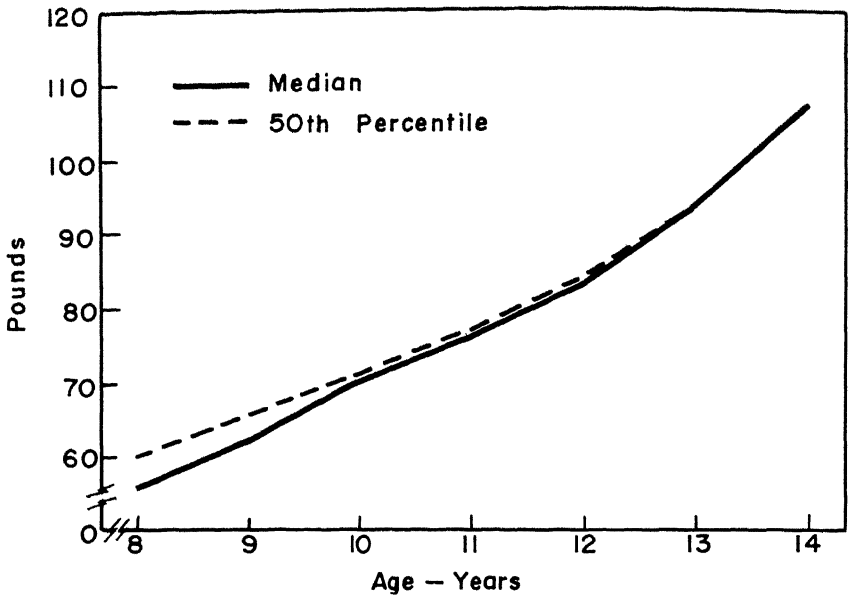


Fig. 11.—Median weights for boys and Stuart and Meredith 50th percentiles at ages 8 to 14.

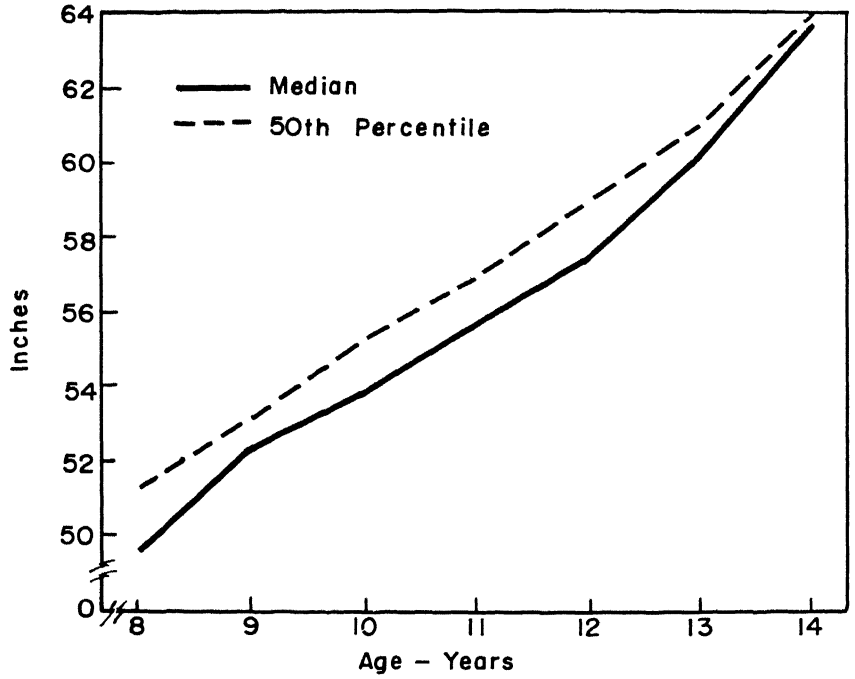


Fig. 12.—Median heights for boys and Stuart and Meredith 50th percentiles at ages 8 to 14.

sharply. For the girls the peak of height gains preceded weight gains by about a year. Height and weight increases followed the same pattern, however, except for a temporary decline in rate of gain for height at 9-10 while weight gains increased steadily.

Average weight gains for the boys exceeded the expected at all ages except at 12-13 (fig. 14). Expected gains reached a peak at 13-14, while means for boys in this study were still rising.

Actual increments in height followed the same general pattern as did expected gains except for the years 9-11; rate of actual gain decreased at age 10-11 while the expected was fairly constant for these ages. Increases or decreases in rate of growth in height for the boys were accompanied by generally similar increases or decreases in rate of weight gains.

Mean increments in height for boys and girls are presented in figure 15. Low points occurred at 9 to 10 for girls and 10 to 11 for boys. A 2-year plateau for height gains occurred for both sexes, specifically at 10 to 12 for girls and 11 to 13 for boys. Beyond this point the rate of gain for girls declined sharply while the boys showed continued gains up to age 14. The fact that only 4 boys were older than 14 needs to be considered in evaluation. Average increments in weight for boys and girls were similar at 8-9 and 11-12 (fig. 16), but in the years between, the rate of gain for the girls increased slowly up to 12 and decreased sharply thereafter. Rate of gain for the boys followed an irregular pattern between 8 and 13 and increased sharply reaching 21.7 lb. for the 14-15 year group (not shown in fig. 16).

More girls than boys attained both expected height and weight increments for the total period. Eighteen of the 33 boys and 31 of the 37 girls made height gains and 32 boys and 31 girls, weight gains. Of those failing to make expected height and/or weight increments for the total period, a larger percentage came from the group who were 10 years of age at the beginning of the study than from any other age group. Percentages of children at various ages who did not reach expected height and/or weight gains for the total period were as follows:

Age at start of study	Gains lower than expected
	% of children
8	27
9	35
10	64
11	12
12	33

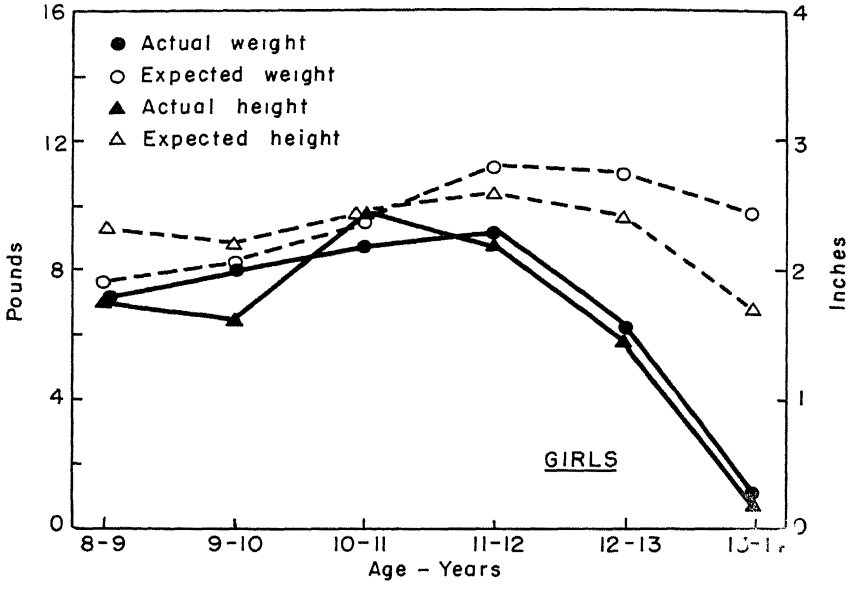


Fig. 13.—Mean and expected increments in height and weight per year for girls.

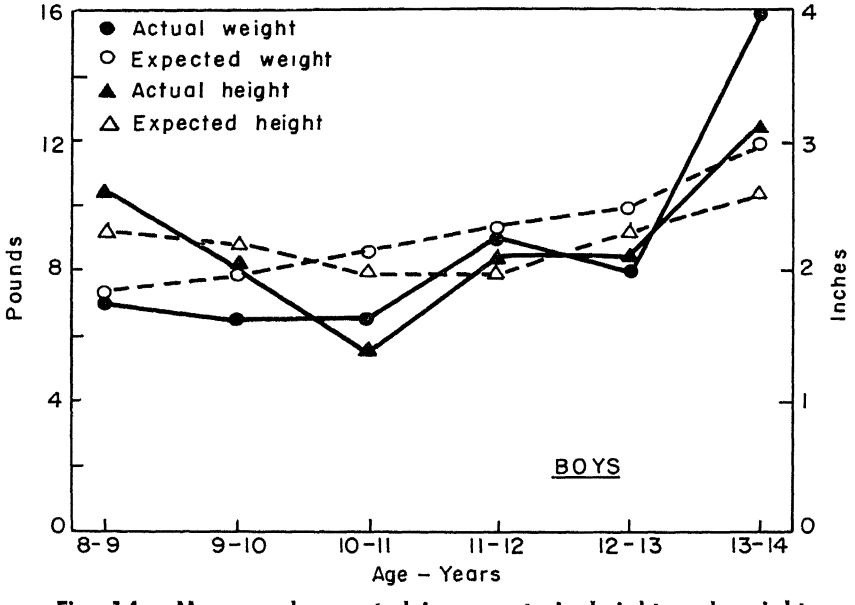


Fig. 14.—Mean and expected increments in height and weight per year for boys.

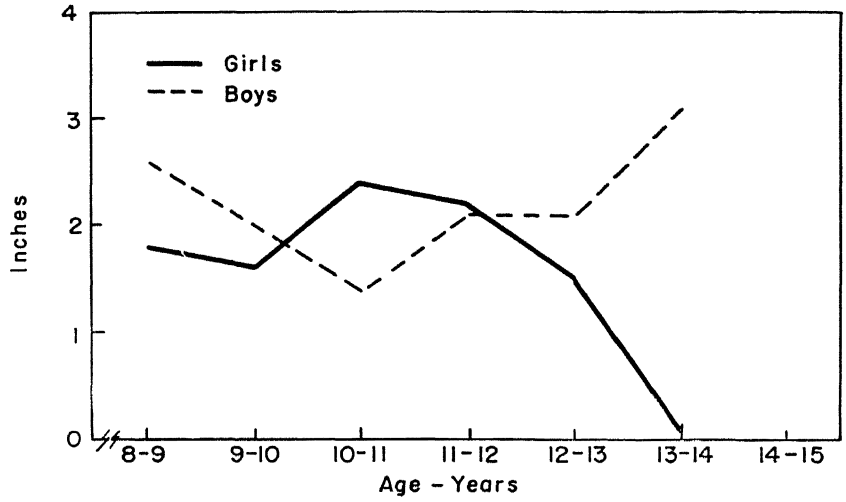


Fig. 15.—Mean increments in heights of girls and boys at ages 8 to 14.

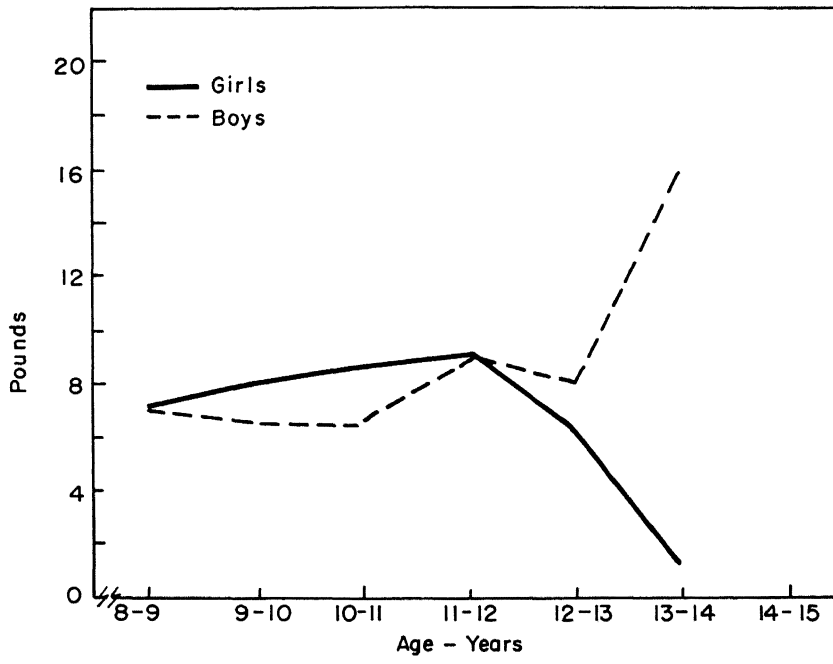


Fig. 16.—Mean increments in weights of girls and boys at ages 8 to 14.

GAINS BY SUPPLEMENTATION PERIODS

Actual and expected monthly gains for height and weight in periods A, B, B' and C[7] were figured for each child but no trend with age by period was evident.

In period B when supplementation was initiated, more children met expected gains than in any other period (table 17). As judged by

Table 17. Growth performance by period and sex in relation to expected gains in height and/or weight

SEX	PERIOD							
	A		B		B'		C	
	Expected	Less than expected	Expected	Less than expected	Expected	Less than expected	Expected	Less than expected
	%	%	%	%	%	%	%	%
Girls	59	41	73	27	49	51	31	69
Boys	38	62	38	62	28	72	55	45
All	49	51	57	43	39	61	42	58

dietary records, diets were somewhat better in this period than in the other periods. This may have had some effect on growth performance. Since a larger percentage of the girls than of the boys made their expected gains in height and weight in the first 2 periods of the study, the assumption is that the extra food provided by the supplementation program came at an advantageous time.

GROWTH AND SCHOOL LUNCH PARTICIPATION

A larger percentage of school lunch participants than of non-participants made expected height and weight gains in periods A and B'; about equal percentages of children from both groups had expected increments in the other 2 periods (table 18). As a whole, 90 percent of the school lunch participants, compared to 75 percent of the non-participants, made expected increases in both height and weight.

PHYSICAL MEASUREMENTS OF CHILDREN COMPARED TO BIRTH WEIGHT AND TO SIZE OF PARENTS

Some workers have related physical measurements of children to their birth weight; others to size of parents. At the end of this study, little if any relationship was found between either the Wetzel ratings for the children and their respective birth weights or the size of their parents. Seven children, for instance, were in the A_4 (obese) channel

[7]Period A (1953-54)—no supplementation; periods B and B' (1954-55 and 1955-56)—supplementation program in progress; and period C (1956-57)—post-supplementation observation period.

Table 18. Growth performance in relation to expected gains in height and/or weight by period and participation in the school lunch

SCHOOL LUNCH PARTICIPATION	PERIOD A		B		B'		C	
	Expected	Less than expected	Expected	Less than expected	Expected	Less than expected	Expected	Less than expected
	%	%	%	%	%	%	%	%
Ate school lunch	54	46	56	44	42	58	42	58
No school lunch	25	75	58	42	25	75	42	58

at the end of the investigation but only 3 of them had been large babies (8 pounds or more at birth). On the other hand, one of the 14 children who had been large babies was retarded in physical development and 10 were in medium or slender channels. Only 2 children had been premature babies, weighing about 5 pounds each at birth, and both were in advanced developmental levels at the final measurements.

Regarding size of parents in relation to size of their children, 6 mothers were considered to be obese and 4 fathers were of heavy build, but none of their children were in Wetzel channels stockier than A_1. In no cases were both parents of a child obese.

SUMMARY

Physical measurements of the 70 children participating in the longitudinal study were taken at regular intervals during the school years from the fall of 1953 to the spring of 1956 and continued periodically but less frequently during 1956-57. Standard procedures were used. These measurements were compared with Baldwin-Wood and Pryor standards and were plotted on Wetzel physique channels.

At each measurement period about half of the girls were normal in weight and height (within ± 9 percent) by the Baldwin-Wood standard whereas by the Pryor tables a slightly larger proportion of the girls were within this range. By both standards more girls were classed as thin (at least 10 percent below the standard) than heavy (10 percent or more above the standard). Nearly two-thirds of the boys were within the normal range of height and weight by the Baldwin-Wood tables and slightly larger percentages were in this classification by the Pryor standards.

More individual fluctuations among the 3 classifications (normal, heavy and thin) occurred for both sexes over the 4-year observation period by Pryor than by Baldwin-Wood standards.

By the Baldwin-Wood standard nearly two-thirds of all children started and ended the study in the same interval of variation from their expected weight for height; about a tenth became thinner and slightly more than a fourth became heavier. By Pryor standards, on the other hand, fewer than half of the children maintained the same degree of variation from "normal"; about a third became heavier and a fifth thinner. A small percent of the children had measurements either too small or too large to be compared with the Pryor tables.

By the Wetzel channels and physique ratings, about half of the children were in the medium (A_1MB_1) channel and those who changed tended toward a stockier channel. Differences in distribution of girls and boys among channels were noted. In general, a higher percentage of boys (60 percent) than of girls (40 percent) was in the medium channel. A large proportion of girls compared to boys were thin or very thin and continued in this category.

Mean heights and weights for girls 8 through 13 years of age were greater than for boys of the same ages. Average weights for both boys and girls exceeded the median at all ages except at age 10 for boys. Medians and averages for height were more nearly alike than they were for weight for both sexes.

Although actual mean gains in weight for girls 8 to 11 years of age were greater than expected as calculated from values presented by Watson and Lowrey (25), the peak was lower and was attained about a year ahead of the predicted; the actual peak came at 11 to 12 years of age. The peak in height gains preceded that in weight by about a year and occurred at age 10 to 11.

For boys, actual average weight gains had not yet reached a peak by the end of the study. The peak in expected gains came at 13-14.

Some fluctuation occurred in the rate of gain in weight and height for both sexes. Rise or fall in rate of growth in height for boys was generally accompanied by a similar increase or decrease in rate of weight gain.

More of the boys and girls gained predicted amounts in period B, the first year of the supplementation program, than in either of the other 2 periods. Relationships between growth and diet were indicated. For example, nutrient intakes were more nearly up to the recommended allowances in period B than in the other 2 periods. Further, about 90 percent of the children who ate the school lunch, compared to 75 percent who did not, made at least expected gains in both height and weight during the study.

Table 19. Distribution of children by level of nutrients in diet and educational level achieved by parents

PARENTS' EDUCATION	NO. CHILDREN	LEVEL OF NUTRIENTS IN CHILDREN'S DIETS*								
		Period A			Period B			Period B'		
		Group I	Group II	Group III	Group I	Group II	Group III	Group I	Group II	Group III
		No.	No.	No.	No.	No.	No.	No.	No.	No.
Mother										
Eighth grade or less	12	1	6	5	1	7	4	1	9	2
Some high school	17	2	10	5	4	10	3	1	9	7
High school graduate	27	2	18	7	2	18	7	1	19	7
Technical or special training	4	0	3	1	1	2	1	0	3	1
Some college	6	1	3	2	0	6	0	0	5	1
Unknown	4	1	2	1	0	3	1	0	2	2
Father										
Eighth grade or less	22	0	14	8	2	14	6	0	13	9
Some high school	16	4	9	3	4	11	1	1	13	2
High school graduate	17	1	9	7	2	10	5	2	10	5
Technical or special training	0	0	0	0	0	0	0	0	0	0
Some college	6	1	3	2	0	5	1	0	4	2
Unknown	9	1	7	1	0	6	3	0	5	4

* Group I All nutrients 100 percent or more of recommended allowances
Group II Some nutrients between 67 - 99 percent but none less than 67 percent of recommended allowances
Group III Some nutrients less than 67 percent of recommended allowances

PART IV. DENTAL AND PHYSICAL INSPECTIONS

Dental Inspections. Dental inspections of permanent teeth of the 70 children participating in this study were made at the school by a practicing dentist from a neighboring community 6 times during the study—in the fall and spring of each of the 3 periods. Findings from these examinations are summarized below and in figure 17. Reports of each child's needs were sent to his home.

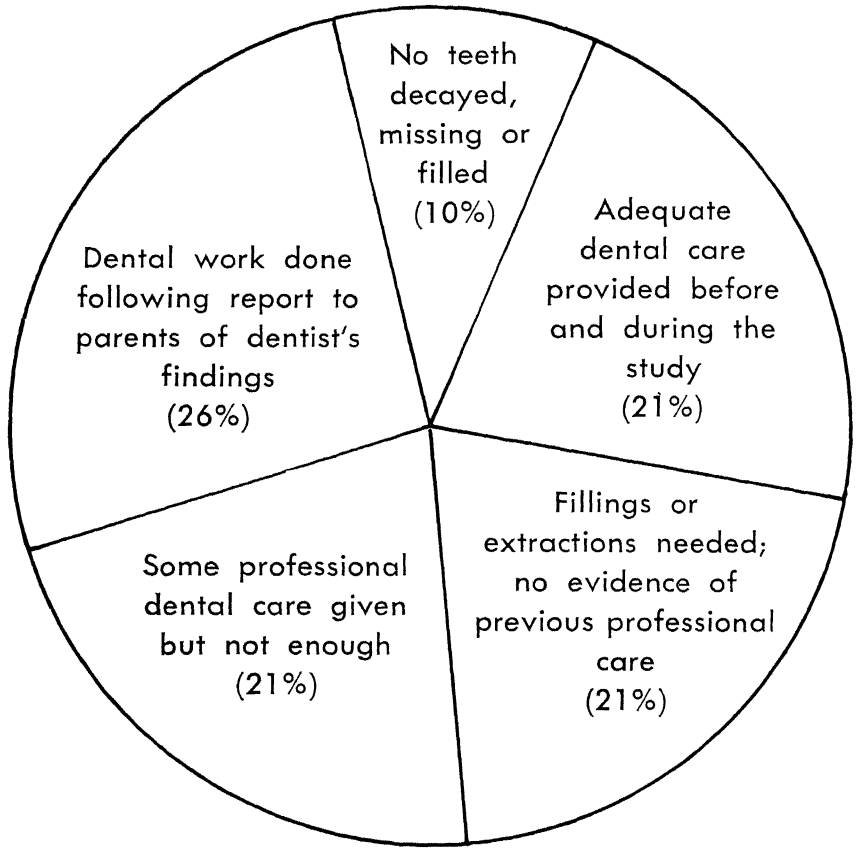


Fig. 17.—Dental conditions among 70 children in an Ohio school during a 3-year study.

	Boys No.	Girls No.	Total %
Teeth and oral cavity in good condition; no decayed, missing or filled teeth; normal gums and no orthodontic treatment indicated	4	3	10
Teeth required filling or extraction but no dental care had ever been given	8	7	21
Some dental attention but not enough had been given. (In most cases cavities were neglected until extraction of teeth was necessary.)	8	7	21
Adequate dental care given before and during the study	3	12	21
Dental work done upon recommendations to parents following dental inspections	10	8	26
Need for orthodontic treatment indicated (in some cases in addition to above conditions)	10	8	26

Only 10 percent of the children (12 percent of the boys and 8 percent of the girls) had teeth which had never required dental work. Forty-two percent of the children were victims of complete or partial dental neglect; in fact, during the 3 years of this study several children lost teeth which might have been saved had reports sent to each child's home after each inspection been heeded.

Twenty-one percent of the children (9 percent of the boys and 32 percent of the girls) had been receiving regular dental attention prior to the study and the care was continued during the inspection. Further, parents of 26 percent of the children (33 percent of the boys and 22 percent of the girls) attended to their children's needs for dental care when the need was brought to their attention.

Physical Inspections. The children were given physical inspections by a physician on the same dates as dental inspections were done. Eyes, skin, mouth, lips and tongue, reflexes and musculature were among the areas scrutinized for conditions likely to be reflections of nutritional deficiencies.

The physician recorded no clearcut signs of poor nutrition at any of the inspections. No striking changes in any of the children, therefore, were expected to result from the supplementation program.

REFERENCES

PART I. Dietary Findings

1. Eppright, E. S., A. L. Marlatt, M. B. Patton et al. Nutrition of 9-, 10- and 11-year-old Public School Children in Iowa, Kansas and Ohio. I. Dietary Findings. NC Reg. Pub. No. 59, Iowa Agr. Exp. Sta. Res. Bull. 434. December 1955.
2. Watt, B. K. and A. L. Merrill. Composition of Foods, Raw, Processed, Prepared. USDA Handbook No. 8. 1950.

3. Bowes, A. de P. and C. F. Church. Food Values of Portions Commonly Used. 6th ed., Anna De P. Bowes, Philadelphia. 1946.

4. Carver, A. F. and M. B. Patton. Plate waste in a school lunch. 1. Over-all waste. J. Am. Dietet. Assoc. 34:615. 1958.

5. Patton, M. B., A. F. Carver and F. E. Hunt. Plate waste in a school lunch. 2. Sources of waste. J. Am. Dietet. Assoc. 34:733. 1958.

6. Hunt, F. E., M. B. Patton and A. F. Carver. Plate waste in a school lunch. 3. A vegetable acceptance study. J. Am. Dietet. Assoc. 34:810. 1958.

7. Bash, W. D. Ohio's Fourth Annual School Milk Program. Ohio Dairy Products Association. 1957.

8. Clayton, M. M. and D. E. Ullman. Remodeling the School Lunch for the Teen-ager. Maine Agr. Exp. Sta. Bull. 475. 1949.

9. Marlatt, A. L., E. S. Eppright, M. B. Patton and M. L. Hathaway. Nutrition of Children in Three Selected Schools in Iowa, Kansas and Ohio. A Pilot Study. NC Reg. Pub. No. 70, Kansas Agr. Exp. Sta. Tech. Bull. 81. July 1956.

10. Moser, A. M. School Lunches in Two Rural Communities. South Carolina Agr. Exp. Sta. Circular 66. 1943.

11. Abbott, O. D., R. O. Townsend, R. B. French and C. F. Ahmann. Effectiveness of the School Lunch in Improving the Nutritional Status of School Children. Florida Agr. Exp. Sta. Bull. 426. 1946.

PART II. Blood Findings

12. Patton, M. B., E. S. Eppright and A. L. Marlatt et al. Nutritional Status of 9-, 10- and 11-year-old Public School Children in Iowa, Kansas and Ohio. II. Blood Findings. NC Reg. Pub. 72, Ohio Agr. Exp. Sta. Bull. 794. September 1957.

13. Lowry, O. H., J. A. Lopez and O. A. Bessey. The determination of ascorbic acid in small amounts of blood serum. J. Biol. Chem. 160: 609. 1945.

14. Committee on Nutrition Surveys, Food and Nutrition Board. Nutrition Surveys: Their Techniques and Values. National Research Council Bulletin No. 117. National Academy of Sciences, Washington 25, D. C. May 1949.

15. Bessey, O. A. and O. H. Lowry. Nutritional Assay of 1,200 New York State School Children. In Meals for Millions, Final report of the New York State Joint Legislative Committee on Nutrition. Legislative Document No. 61. 1947.

16. Jolliffe, N., R. S. Goodhart, M. Archer, H. Lopez and F. G. Diaz. Nutrition status survey of the sixth grade school population of Cuba. J. Nutrition. 64(3):355-398.

17. Mugrage, E. R. and M. I. Andresen. Red blood cell values in adolescence. Am. J. Diseases Children. 56:997. 1938.

18. Harrison, D. L., A. L. Marlatt, E. B. Alsup, E. S. Eppright, C. E. Roderuck and M. B. Patton. Nutrition of 9-, 10- and 11-year-old Public School Children in Iowa, Kansas and Ohio. III. Physical Findings. NC Reg. Pub. 99, Kansas Agr. Exp. Sta. Tech. Bull. 101. June 1959.

PART III. Physical Measurements

19. Baldwin, B. T. and T. D. Wood. Weight-Height-Age Tables for Boys and Girls. American Child Health Assoc., New York. 1932.

20. Pryor, H. B. Width-Weight Tables. 2nd rev. ed., Stanford University Press, California. 1940.

21. Wetzel, N. C. Grid for Evaluating Physical Fitness. NEA Service, Inc., Cleveland. 1941.

22. Patton, M. B. and F. E. Hunt. Growth patterns of Ohio school children. J. Am. Dietet. Assoc. 35(5):457-461. 1959.

23. Stuart, H. C. Normal growth and development during adolescence. New England J. Med. 234:666 and 732. 1946.

24. Wetzel, N. C. Physical fitness in terms of physique, development and basal metabolism. J. Am. Med. Assoc. 116:1187. 1941.

25. Watson, E. H. and G. H. Lowrey. Growth and Development of Children. 2nd ed., Year Book Publishers Inc., Chicago. 1954.

APPENDIX

DESCRIPTION OF FAMILIES

Marital Status of Parents. Home background information was obtained from 58 families representing 69 of the 70 children participating in the longitudinal study. Four of the children, all boys, were living with one parent only; one girl lived with grandparents, and in a few families a child was living with a natural parent and a step-mother or step-father.

Employment of Mothers. Sixteen mothers (28 percent, representing 9 boys and 10 girls) were gainfully employed. In a few cases the family depended wholly upon the mother's income for a living. Occupations of the employed women ranged from factory workers and cafeteria helpers to saleswomen, office workers, food service managers and teachers.

Age of Parents. The mean age for fathers was 43.3 years and for mothers, 39.7. The median age for both sexes fell within the 40 to 44 year range. Distribution of parents by sex and age was as follows:

Age	No. Fathers	No. Mothers
25–29	1	1
30–34	7	13
35–39	8	12
40–44	16	15
45–49	12	12
50–54	9	2
55–59	2	--
All	55	55

Education of Parents. Both fathers and mothers had an average of 10.3 years of formal education. The median was 10 years for fathers and 12 for mothers. Distribution by educational level was as follows:

Level of Formal Education		No. Fathers	No. Mothers
Grade	6	1	3
	7	1	0
	8	17	7
	9	5	3
	10	7	7
	11	4	4
	12	12	22
College	1	0	3
	2	3	1
	3	0	1
	4	1	0
Graduate work		1	0
M. S. degree		1	0
Specialized or technical training		0	4
Registered Nurse		--	1
Unknown		5	2
All		58	58